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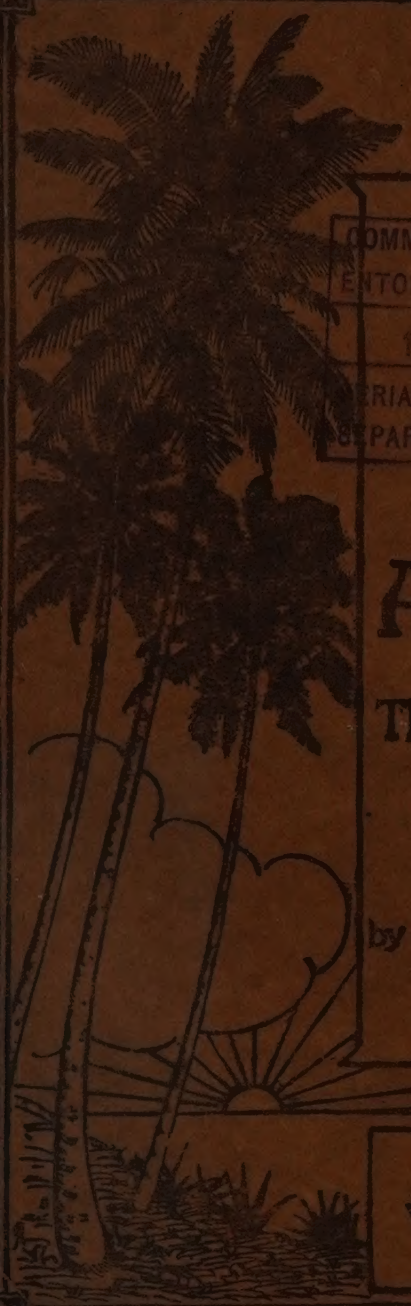

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EDITORIAL

AGRICULTURAL RESEARCH

IT has been estimated that the total area of land which is cultivable in the world amounts to about 10,000 million acres. This estimate is of the absolute maximum which could be brought under crops and it includes a large amount of land which, for one reason or another, would probably not be economically cultivable. Parts would be of a character which could only give low yields due to precarious rainfall, low temperatures, unsuitability for irrigation or mechanised tillage, geographical inaccessibility rendering transport of produce to consuming centres prohibitively costly, and so forth. When all these adverse factors are allowed for it is probable that only half the total area cultivable could be considered as practical farming land. Estimates of the world population place it at somewhat over 2,000 million but these estimates are necessarily rather vague because many large countries do not render census figures which can be considered better than guesses. There is evidence that this population is increasing at a rate of between 20 and 25 million persons a year and there is no reason to suppose that this will cease. Indeed, with the spread of modern medical and sanitary measures it may well rise still further.

On the basis of 5,000 million acres which can be cultivated without great difficulty, the present estimated population of 2,000 millions has to be fed and supported on 2·5 acres each. For a number of reasons this area cannot be entirely devoted to food production. There must be a part set aside for essential consumer goods such as cotton and other fibres, drugs which have not yet been synthesised, essential oils, rubber, animal products such as leather, reserved areas to check soil erosion, amenity products such as tea, coffee, cocoa and tobacco which, though possibly not essential for the support of human life, have become so important in relieving the burden of human existence that they cannot be entirely eliminated.

In some highly industrialised areas and places of high concentration of population a further alienation of land from agriculture is progressively occurring for industrial and domestic purposes. The impossibility of effecting universal control of soil erosion causes a further shrinkage. The overall picture is that the possible 5,000 million acres of reasonably good land is continually shrinking and less and less remains available for feeding the world's population which, in turn, is continually rising. The area under crops at the present time, as distinct from the possible cultivable area, is estimated by Prasolov at 3,600 million acres or only 1·8 acres per person. This includes all the non-food crops as well as those which might be classed as essential to human life. The immediate world prospect is therefore one which can only cause apprehension.

Even if the present world food production could be raised to pre-war levels it would still be insufficient to maintain the per capita consumption because of the rise in population during the war years. If only the present levels of food consumption are to be maintained a large increase in production is necessary. In the past year there has been some improvement in world food production but this increase has been more than absorbed by the increase in consumers. In the 20 years between 1910 and 1930 there was an estimated increase in the cultivated acreage of somewhat over 110 million acres, but it is a notable and somewhat disturbing fact that there has been no comparable increase since the end of World War II. This is probably due in part to the non-availability of any large areas which can easily be brought under the plough, and in part to the widespread and long sustained unrest which has characterised the post-war years. The shrinkage of suitable virgin land is a fact which cannot be escaped, and this leads to the conclusion that it is mainly by increased production per acre that the gap between production and consumption can be filled.

Increased production, meaning a bigger return for work done and more efficient use of the land, has long been the aim of agriculturists. There are areas where this has been achieved with considerable success, but they are to be found in the more highly developed countries where the application of the discoveries of science are well understood and the social and economic conditions do not hinder the adoption of new methods involving social changes. In very large areas there have been little or no improvements in yields over centuries, while in some, owing to erosion and falling fertility, there has even been a decline. The application of the most modern scientific principles lags far behind the discovery of new methods. The lag is due to ignorance on the part of the small farmer and in part to economic difficulties which hinder the adoption of new methods. The first hindrance can only be overcome gradually by patient teaching and demonstration, particularly practical demonstration on the farmers' own land. For example, it is quite certain that the rice yields of Ceylon could be very materially raised by means within the reach of the ordinary villager and at a profit if better farming methods were generally employed. Besides the application of known improvements there is room for a great deal of further investigation both into the suitability of scientific discoveries to local conditions of soil and climate as well as into entirely new aspects of agriculture.

There are two main branches of agricultural research which need to be pursued to the fullest extent. There is what may be termed local research into the applicability of known methods to local conditions and into their modification to suit regional variations, while there is the rather distinct, more fundamental and somewhat more academic side, though still to be classified as applied research. These two aspects, the one dealing with the details of the application of methods to practical farming and the other studying basic problems, need rather different men and equipment. The first belongs to the field while the latter savours more of the laboratory, but neither can be entirely separated from the other. To take an example, the methods used in selecting an improved strain of a crop are well established but they must be used by skilled workers on each and every crop it is desired to improve by breeding methods, and not only on each crop but for each locality in which that crop is to be grown. This class of research must be done in the field to a very large extent. On the other hand, such a problem as the fixation of phosphates in the soil is not merely a field problem but one which needs laboratory investigation by the most refined methods. While the farmer has direct financial interest in the way the phosphate he applies to his fields becomes unavailable or is recoverable as residual effects over a period of years, it is unlikely that the problem will ever be satisfactorily solved elsewhere than in the chemist's laboratory.

No exact division between these aspects of research is possible. They range from technological research through somewhat more basic investigations up to the purely academic side having no immediate application. It is probable that greater immediate gains are likely from applied research into those problems which are hindrances to progress, and it is clearly the duty of agricultural research organisations to tackle these problems first but not to the entire exclusion of more fundamental work. The field research worker is an essential part of the organisation because on him depends the final shaping of the new method to local conditions so that it may be within the skill and financial resources of the farmer. It may be said that this "technological" aspect is not what is usually meant by research, but it is hard to draw a line, and very often there is as much skill and resource necessary for the final shaping of a new method as in its original discovery. These three stages in progress, the first discovery of new facts, their adaptation to local conditions and the dissemination of the new knowledge are three essential stages in the improvement of yields from existing cultivated areas.

The amount of improvement which it has been possible hitherto to obtain is often very considerable and no scientist would admit that the limit has been reached in any crop. Wheat yields have been doubled by breeding methods while the areas where the crop can be grown have been enormously extended by breeding types adapted to special climatic conditions. The application of fertilizers on scientific principles, though these are still not fully understood, has led to very large increases and in many crops are essential for economic production. Control of pests and diseases by cultural, chemical, biological and genetical means have enabled crops to be grown which would otherwise have been impossible in large areas where conditions favour the rapid multiplication of parasites.

In Ceylon there has been a strongly developed research side to the Agricultural Department dating back to the early years of the Royal Botanic Gardens, and the record of achievement is notable. It is true, however, that for many years the research was directed largely towards the plantation industries to the comparative neglect of annual crops and of agronomy. In later years there has been a re-orientation of research. The problems of the plantation industries have become the concern of separate quasi-government commodity Research Boards financed mainly by the industries themselves, while the improvement of peasant crops has been receiving increased attention by the Agricultural Department. There is still room for that very necessary stage of "technological" research in the field, for study of agronomy under rotational cropping, the breeding of better varieties of crops, the testing of fertilizers and the methods of their use and of disease control. The processing of agricultural produce needs more study, as for example, the milling quality of rice (quite distinct in a power mill from hand pounding), the ginning and spinning of cotton, the milling of maize, curing of tobacco, &c. Under a subsistence or near-subsistence type of agriculture, quality is relatively unimportant and largely a matter of personal preferences, but when production exceeds local village needs the requirements of processing plants and distant consumers becomes important. These and similar aspects of agricultural improvement are worthy of more intensive study.

STUDIES IN CASSAVA

II.—THE PRODUCTION OF HYBRIDS

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AND
K. D. S. S. NANAYAKKARA
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THE hybridisation of cassava (*Manihot utilissima Pohl*), all known races of which can be propagated vegetatively, has fascinating possibilities. In this crop, the time-consuming reduction of hybrids to homozygosis becomes not only unnecessary, but undesirable. Familiarity with flower structure and anthesis must, however, precede attempts at hybridization. Published studies on the floral morphology of cassava are neither numerous nor detailed. The data presented in this paper fill a hiatus in our knowledge of those aspects of the botany of cassava which are relevant to breeding technique. An account of preliminary results in the synthesis of a genotype that is both high yielding and poor in prussic acid, is included.

FLORAL STRUCTURE

All Ceylon races of cassava, except MU. 3, MU. 5, MU. 7, MU. 12, MU. 17, MU. 47, MU. 55, MU. 62, MU. 71 and MU. 72 (Chandraratna and Nanayakkara, 1945), flower. The plant is monoecious. Unisexual flowers are borne in inflorescences which are initially racemose. Few female flowers occur at the base of the inflorescence, and numerous males above. Inflorescences occasionally bear only female flowers. An analysis of the composition of a sample of one hundred inflorescences is given in Table 1.

The structure of normal male and female flowers has been described in the first part of this series (Chandraratna and Nanayakkara, 1945), and is illustrated in Fig. 1*a* and *b*. In several races, *e.g.*, MU. 16, MU. 19, MU. 38, MU. 42, MU. 43 and MU. 61, the male flowers are abortive (Fig. 1*c*), rarely open, and never produce functional pollen. Aberrant female flowers with varying numbers of staminodes (Fig. 1*d* and *e*) are not uncommon in certain races. The distribution of abnormal staminode-bearing females in the race MU. 23, and in the hybrid MUh. 19, is given in Table 2. The staminodes that occur in these abnormal females may vary from mere vestiges of filaments to stamens with recognizable anthers. In no staminode, however, is viable pollen found. Female flowers with similar staminodes occur in the related species *Manihot glaziovii* Mull-Arg.

TABLE 1.—Distribution of Male and Female Flowers in a Sample of Hundred Inflorescences

Number of Flowers in Inflorescence	Frequency		
	Males	Females	Males and Females
0	3	0	0
1	1	9	
2	1	77	
3	2	13	4
4	0	1	1
5	4		2
6	9		0
7	16		5
8	13		10
9	22		13
10	20	0	14
11	8		21
12	1		18
13	0		10
14			2
Mean No. per Inflorescence	7·88	2·06	10·03
Standard Deviation	± 2·81	± 1·44	± 3·17

TABLE 2.—Distribution of Abnormal Females in MU. 23 and MUh. 19

Number of Staminodes in Female Flower	Frequency	
	MU. 23.	MUh. 19.
0	483	740
1	30	24
2	6	2
3	1	3
4	1	1
5	0	2
Mean No. Per Flower.	0·101	0·0689
Standard Deviation.	± 0·318	± 0·262

ANTHESIS

The results given below were collected in Peradeniya during the years 1939–1945. A detailed record of anthesis in cassava has not been published elsewhere, and the applicability of these results to other areas is unknown. Blooming is notoriously subject to climatic influences, and may vary even in different parts of the Island. Results obtained in Peradeniya in successive seasons have, however, been remarkably uniform.

Table 3 which is derived from a sample of one hundred inflorescences indicates marked protogyny. The male flowers do not commence opening till the last female flower on the inflorescence has bloomed.

Fig. 1. Manihot utilissima Pohl. a, normal male flower; b, normal female flower; c, abortive male flower; d & e. abnormal female flowers with staminodes

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Time of Daily Flowering.—The curve for male blooms has a smaller standard deviation than that for female blooms. A feature of blooming in both males and females is the concentration of blooming into a relative short period immediately after midday : 91 per cent. of male flowers bloom between 12.30 P.M. and 1.30 P.M., and 96 per cent. of female flowers bloom between 12 noon and 1.30 P.M. The mode for female blooms lies between 12.30 P.M. and 1 P.M. The blooming of males reaches its peak slightly later than the blooming of females, but before 1.30 P.M. No male or female flower was observed to bloom before 11 A.M. or after 2 P.M. The perianths commence closing after 2.30 P.M. By 4.30 P.M. nearly all the flowers have closed.

Neither crude nor partial correlation coefficients of blooming frequency with temperature and relative humidity reached significance. There is little doubt, however, that these factors influence blooming profoundly.

Size of buds on day previous to blooming.—In the bagging of male and female buds, the recognition of buds that are due to open the following day becomes necessary. Size is a relatively satisfactory criterion of maturity. The lengths and diameters, on the day previous to blooming, of male and female buds in five races is given in Table 4. The recorded diameter in the instance of the female, is the diameter of the circular base of the conical bud.

There are significant differences in size between buds of different races at comparable stages of maturity. Measurements should accordingly be made in the instance of each race used in hybridisation.

TABLE 4.—Bud Size on Day Previous to Blooming

Race	Sex	Length of Bud in mm.			Diameter of Bud in mm.		
		Range.	Mean.	Standard Error.	Range.	Mean.	Standard Error.
MU. 46	Male	6·5–7·5	7·0	±0·058..	4·3–5·0	4·8	±0·062
MU. 57	Male	6·0–7·8	6·9	±0·161..	4·9–6·2	5·2	±0·10[illegible]
MU. 50	Female	7·8–9·2	8·3	±0·120..	4·5–5·1	4·9	±0·07[illegible]
MU. 63	Female	6·9–8·0	7·2	±0·085..	4·3–5·1	4·8	±0·0[illegible]7
MU. 65	Female	7·0–8·3	7·9	±0·083..	4·2–6·0	5·1	±0·[illegible]28

Receptivity of the Stigma.—The need for pollination before the opening of the female flower does not normally arise in hybridisation work, and the question of the receptivity of the stigma in the bud was accordingly not investigated. The stigma exhibits receptivity at the time of blooming, but rapidly loses it. The stigma becomes unreceptive within 24 hours, and is shed within 48 hours.

Dehiscence of Anthers and Longevity of Pollen.—Dehiscence of anthers commences 2–2½ hours before the opening of the flower, but is completed only during the hour preceding blooming. After the flower opens, the smooth, spherical pollen grains are rapidly dissipated by wind, and the pollen sacs are almost completely empty by sunset.

TABLE 3.—Progress of Blooming in a Sample of One Hundred Inflorescences

Date		Time (A.M. / P.M.)						Male Blooms		Female Blooms	
		11–11.30	11.30–12	12–12.30	12.30–1	1–1.30	1.30–2	Total	Percentage	Total	Percentage
June 21	No. of Female Blooms	1	0	15	50	23	7			96	47·29
22	No. of Male Blooms	0	0	0	2	0	0	2	0·46		
	No. of Female Blooms	0	0	17	24	15	0			56	27·59
	Temperature °C	28·3	28·2	28·7	29·2	30·6	31·2				
23	No. of Male Blooms	0	0	0	11	1	0	12	2·74		
	No. of Female Blooms	0	0	2	14	7	0			23	11·33
	Temperature °C	28·0	26·8	28·0	29·1	28·5	28·2				
	Relative Humidity %	—	68	60	59	61	62				
24	No. of Male Blooms	0	0	0	4	0	0	4	0·91		
	No. of Female Blooms	0	1	0	15	7	0			23	11·33
	Temperature °C	27·0	28·5	28·0	28·9	29·3	28·3				
	Relative Humidity %	—	58	60	59	57	62				
25	No. of Male Blooms	0	0	0	10	2	0	12	2·74		
	No. of Female Blooms	0	0	1	3	1	0			5	2·46
	Temperature °C	26·5	27·7	28·1	28·9	28·6	28·2				
	Relative Humidity %	—	62	63	59	59	62				
26	No. of Male Blooms	0	0	0	3	5	0	8	1·83		
	Temperature °C	26·8	27·3	28·3	25·8	26·4	27·5				
	Relative Humidity %	—	65	63	80	71	65				
27	No. of Male Blooms	0	0	0	4	16	0	20	4·57		
	Temperature °C	26·4	27·1	27·8	27·4	27·9	28·2				
	Relative Humidity %	—	61	59	59	60	60				
28	No. of Male Blooms	0	0	0	3	5	1	9	2·05		
	Temperature °C	25·8	26·5	26·9	27·7	28·8	29·5				
	Relative Humidity %	—	71	69	64	59	61				
29	No. of Male Blooms	0	0	0	6	17	0	23	5·25		
	Temperature °C	27·3	27·5	28·6	28·8	28·7	29·5				
	Relative Humidity %	—	67	60	60	62	60				
30	No. of Male Blooms	0	0	0	33	21	1	55	12·56		
	Temperature °C	27·5	28·9	29·6	29·8	30·3	30·3				
	Relative Humidity %	—	59	56	57	55	53				
July 1	No. of Male Blooms	0	0	0	8	25	13	46	10·50		
	Temperature °C	26·7	27·6	28·2	27·4	27·5	28·7				
	Relative Humidity %	—	67	62	65	65	62				
2	No. of Male Blooms	0	0	0	3	20	9	32	7·31		
	Temperature °C	26·6	26·8	28·1	28·0	28·1	27·7				

Date		Time						Male Blooms		Female Blooms	
		A.M.			P.M.			Total	Percentage	Total	Percentage
		11–11.30	11.30–12	12–12.30	12.30–1	1–1.30	1.30–2				
July	Relative Humidity %	—	65	64	68	67	67				
3	No. of Male Blooms	0	0	0	26	26	4	56	12·79		
	Temperature °C	26·9	28·1	29·0	28·6	28·1	27·4				
	Relative Humidity %	—	57	55	56	62	63				
4	No. of Male Blooms	0	0	0	17	4	3	24	5·48		
	Temperature °C	27·0	28·9	30·0	28·8	29·6	28·7				
	Relative Humidity %	—	57	54	56	54	56				
5	No. of Male Blooms	0	0	0	0	6	2	8	1·83		
	Temperature °C	26·0	24·8	26·4	25·7	26·5	26·6				
	Relative Humidity %	—	84	97	86	85	86				
6	No. of Male Blooms	0	0	1	34	40	4	79	18·04		
	Temperature °C	27·1	28·3	28·6	29·3	30·3	29·5				
	Relative Humidity %	—	59	57	57	52	54				
7	No. of Male Blooms	0	0	0	3	35	0	38	8·68		
	Temperature °C	28·1	27·8	29·9	27·7	29·7	30·0				
	Relative Humidity %	—	54	52	61	55	52				
8	No. of Male Blooms	0	0	0	3	0	0	3	0·68		
	Temperature °C	28·8	29·0	30·0	29·3	29·5	26·8				
	Relative Humidity %	—	60	55	57	55	64				
9	No. of Male Blooms	0	0	0	7	0	0	7	1·60		
	Temperature °C	28·8	30·1	31·3	30·9	30·2	29·1				
	Relative Humidity %	—	50	45	46	53	56				
Male Blooms	Total	0	0	1	177	223	37	438		—	—
	Percentage	0·00	0·00	0·23	40·41	50·91	8·45	—	100	—	—
Female Blooms	Total	1	1	35	106	53	7	—	—	203	—
	Percentage	0·49	0·49	17·24	52·22	26·11	3·45	—	—	—	100
Mean Temperature °C		27·2	27·8	28·6	28·4	28·8	28·6				

(Rows for blooms of a particular sex have not been inserted in the table against dates on which no flowers of that sex have bloomed.)

Pollen stored over calcium chloride for periods of 0, 2, 4, 6 and 8 days, was tested on receptive stigmas. Seed set was achieved with 6-day-old pollen, but not with 8-day-old pollen.

Natural Pollination.—The prolific production of readily disseminated pollen suggests that wind is an important pollinating agency. The profuse secretion of nectar, however, attracts numerous insect visitors, of which the commonest is the bee, *Apis florea* Fabricius. These insects probably provide an alternative agency.

The nectary in both males and females commences secreting 2–3 days before the flower opens. In the instance of the pendent female buds, the copious nectar completely smears the stigma. Insects often puncture both male and female buds, and steal nectar.

Interval between Pollination and Fertilization.—The excision of the stigma at intervals after the deposition of pollen provides a technique for determining the interval between pollination and fertilization, or—to be more precise—the interval between pollination and the passage of male nuclei down the style. Tests showed that this interval exceeded eight hours, and was under 19 hours.

Parthenocarpy.—Hand pollination often results in seedless fruits. Fruits set when *M. Glaziovii* pollen was deposited on cassava stigmas. The F_1 generation exhibited no *Glaziovii* characters, and appears to have been parthenocarpic.

TECHNIQUE OF CROSSING

Either after 3 P.M. on the evening previous to crossing, or before 10 A.M. on the day crossing is due, inflorescences on the male and female parents are enclosed in paper bags. Only flowers of the relevant sex that are due to open on the day of crossing are retained; fruits, flowers of the opposite sex, open flowers, and flowers that are too young are removed. The female flowers are pollinated as they open during the period immediately following midday, by dusting the stigmas with the pollen-laden anthers of collected male flowers. It is not feasible to have more than one male parent for the females on any one inflorescence. The chances of illegitimate pollination by air-borne pollen are considerable and the pollinated females should be paper-bagged with the least possible delay, and labelled. The paper bags should be removed after 48 hours, and a bag of mosquito-netting designed to catch seeds from dehiscing capsules, substituted after the fruits have set (Storey, 1949).

Swelling of the fertilized ovary becomes evident in five days after pollination. Unfertilized ovaries usually drop in about ten days. Seeds mature in 2½–3 months.

Germination of the Seed.—The germination of the seed is slow and erratic, and is probably the most troublesome stage in the production of a cassava hybrid. Intact seeds in some instances do not germinate at all, and in other instances, may take as long as six months to germinate. The effects of rupturing the testa at the ab-embryonic end, and of immersing the seed in boiling water, and in sulphuric acid of various concentrations, were investigated.

The boiling water and sulphuric acid treatments did not induce germination. Rupture of the testa markedly accelerated germination. The results presented in Table 5 are too strikingly conclusive to require statistical analysis. The early germination of testa-ruptured seed indicates that dormancy is not the cause of the delay in the germination of intact seed.

TABLE 5.—The Effect of Rupture of the Testa on Seed Germination

Replicate	Treatment	Percentage Germination at the end of		
		2 Weeks	3 Weeks	4 Weeks
1	Testa intact	0	0	0
	Testa ruptured	0	40	40
2	Testa intact	0	0	0
	Testa ruptured	28	28	32
3	Testa intact	0	0	0
	Testa ruptured	4	8	8
4	Testa intact	0	0	0
	Testa ruptured	4	16	16
5	Testa intact	0	0	0
	Testa ruptured	0	0	8
6	Testa intact	0	0	0
	Testa ruptured	4	8	16
7	Testa intact	0	0	0
	Testa ruptured	28	44	44
8	Testa intact	0	0	0
	Testa ruptured	0	0	12

PROGRAMME OF HYBRIDISATION

All known races of cassava contain varying quantities of the cyanogenetic glucoside, linamarin, from which, in injured or senescent tissue, hydrocyanic acid may be liberated by enzymic action. Cassava roots stored long above ground, for instance, develop lethal concentrations of hydrocyanic acid. Hydrocyanic acid is a potent inhibitory poison affecting primarily the respiratory functions of cells, and secondarily, the oxidation-reduction activities of vitamins and hormones (Clark, 1935).

A breeding programme that aimed primarily at combining high yield of roots with a low content in hydrocyanic acid was initiated in 1939. The race, MU. 41 was chosen as the yield parent. Tuber yields of MU. 41 have been consistently among the highest of the 75 Ceylon races. This race, however, is deplorably rich in hydrocyanic acid. Crosses were effected of MU. 41, with two parents possessing fine flavour and a satisfactory low HCN figure, viz. MU. 51 and MU. 59. Sixteen of the hybrids produced, viz. MUh. 3, MUh. 4, MUh. 5, MUh. 7, MUh. 8, MUh. 9, MUh. 10, MUh. 11, MUh. 12, MUh. 14, MUh. 16, MUh. 17, MUh. 18, MUh. 19, MUh 20 and MUh. 21, and the three parents from which they were derived, are described in the appendix.

The hydrocyanic acid content of the tuber flesh (secondary xylem) of the parents and of the hybrids, at the age of twelve months, is given in Table 6.

TABLE 6.—Hydrocyanic Acid Content of Parents and Hybrids

Hybrid	Parents	HCN content in milligrams per 100 gm. tissue		
		Female Parent	Male Parent	Hybrid
MUh. 3	MU. 41* × MU. 51	10·3	3·4	9·2
MUh. 4	MU. 41 × MU. 59	10·3	4·6	8·0
MUh. 5	MU. 51 × MU. 41	3·4	10·3	7·6
MUh. 7	MU. 51 × MU. 41	3·4	10·3	11·1
MUh. 8	MU. 51 × MU. 41	3·4	10·3	13·3
MUh. 9	MU. 51 × MU. 41	3·4	10·3	13·3
MUh. 10	MU. 41 × MU. 59	10·3	4·6	8·4
MUh. 11	MU. 41 × MU. 59	10·3	4·6	10·0
MUh. 12	MU. 41 × MU. 59	10·3	4·6	7·0
MUh. 14	MU. 59 × MU. 41	4·6	10·3	7·5
MUh. 16	MU. 59 × MU. 41	4·6	10·3	10·3
MUh. 17	MU. 41 × MU. 51	10·3	3·4	9·5
MUh. 18	MU. 51 × MU. 41	3·4	10·3	8·5
MUh. 19	MU. 51 × MU. 41	3·4	10·3	8·5
MUh. 20	MU. 51 × MU. 41	3·4	10·3	8·5
MUh. 21	MU. 59 × MU. 41	4·6	10·3	10·3

* The first mentioned parent in every instance is the female.

Most of the hybrids have given HCN figures nearer those of the HCN-rich parent, MU. 41. In the instance of the hybrids, MUh. 7, MUh. 8 and MUh. 9, inheritance of the HCN content appears to have been transgressive. The HCN figures for the hybrids, MUh. 5, MUh. 12 and MUh. 14, are, however, satisfactorily low. Results of yield tests of these hybrids and their parents will be reported in a later communication.

The only precise conclusion that the F_1 data presented in the appendix permit is that the three parents are highly heterozygous. No decision regarding the dominance or recession of characters is possible. The interpretation is complicated not only by the heterozygosity of the parents, but by possible parthenocarpy.

SUMMARY

The floral biology of cassava was studied as a preliminary to the execution of a breeding programme.

In some races, the male flowers were abortive, rarely opened and never produced functional pollen.

In several races, abnormal female flowers possessing varying numbers of staminodes, occured with appreciable frequency.

The inflorescences were markedly protogynous.

The blooming of both male and female flowers was concentrated into a relatively short period immediately following midday ; 91 per cent. of male flowers bloomed between 12.30 P.M. and 1.30 P.M., and 96 per cent. of female flowers bloomed between 12 noon and 1 P.M.

The size of buds on the day previous to blooming provided a useful index of maturity.

The stigma was receptive at the time of blooming, but lost its receptivity in 24 hours.

Anthers dehisced before blooming.

Pollen stored under desiccation remained functional for at least six days.

Both wind and insects appeared to function as pollinating agencies.

The interval between pollination and the passage of male nuclei past the style was over eight hours, and under 19 hours.

Parthenocarpy appeared appreciably frequent.

The technique of crossing used is described.

Hybrids produced as part of a programme of combining high yield with a low content in hydrocyanic acid, are described.

ACKNOWLEDGMENT

I gratefully thank Messrs. C. Charavanapavan and D. G. Panditheseker a of the Division of Chemistry, Department of Agriculture, for determinations of hydrocyanic acid content, and Mr. A. George Alwis for the illustrations.

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APPENDIX

Parents

MU. 41

(Sinyokka)

Petiole : 48±0·7 cm. long, red (colour deepest at the ends), slightly sigmoid, inclining, horizontal and declining.

Young leaf : Light green ; midrib red.

Mature leaf : Dark green, large, with commonly 9 leaflets ; leaflets broad, not divergent, with distal halves bending down ; central leaflet 24±0·5 cm long and 7±0·1 cm wide.

Petiole scar : Dark purple.

Stem : Yellowish green with red stripes when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females alizarine pink internally and cream externally ; stigma pale pinkish white ; ovary green with pink ridges.

Capsule : Apple green to light green with bright pink wings ; nectary geranium pink.

Tuber : Fat and long ; surface rough, warm buff to dirty white with occasional pink and grey patches ; phelloderm white ; flesh white.

Habit : Commonly unbranched ; occasionally throws out aberrant, early flowering, branches with trifid leaves ; foliage dense.

Distribution : Badulla.

MU. 51.

(Kos-manyokka)

Petiole : 37±0·5 cm. long, yellowish green, shaded rose at the ends, straight, usually inclining, occasionally horizontal.

Young leaf : Light purple tinged with green ; midrib yellow to red.

Mature leaf : Light green, of medium size, with usually 7 leaflets ; leaflets divergent, slightly curved adaxially ; central leaflet 18±0·3 cm. long and 6±0·1 cm. wide.

Petiole scar : Dark purple.

Stem : Yellowish green when young, silver grey when mature.

Flowers : Calyx cream ; sepals of males with pink shading ; sepals of females with pink stripes ; stigma pale pinkish white ; ovary light green with pink ridges.

Capsule : Apple to light green with pink wings ; nectary light coral red.

Tuber : Fat and short ; surface scaly, liver brown to hazel brown ; phelloderm white ; flesh white.

Habit : Low and frequent ; foliage moderately dense ; occasionally abberant branches with trifid leaves and early fruits appear.

MU. 59

(Manyokka)

Petiole : 39±0·5 cm. long, pale green with faint rose ring at proximal end and rose shading at curved distal end, alternately inclining and horizontal.

Young leaf : Purplish green ; midrib light green.

Mature leaf : Light green, of medium size, with commonly 7 leaflets ; leaflets lying close together ; adaxially concave in cross section, with distal halves bending down ; central leaflet 21±0·4 cm. long and 6±0·1 cm. wide.

Petiole scar : Dark green.

Stem : Bright green when young, wood brown to silver grey when mature.

Flowers : Both sexes bloom almost simultaneously ; calyx cream ; males with faint alizarine pink shading ; females with alizarine pink lines ; stigma pale pinkish white ; ovary green with pink ridges.

Capsule : Apple green to light green with bright pink wings ; nectary coral red.

Tuber : Of medium thickness and length ; surface warm buff to light buff with occasional grey patches ; phellederm white ; flesh yellowish white.

Habit : Plants thick-stemmed ; branching high and infrequent ; foliage dense.

Distribution : Paranthan.

Hybrids

MUh. 3

(MU. 41 *× MU. 51)

Petiole : 23±0·7 cm. long, carmine (colour deepest at the ends, sigmoid, commonly declining, occasionally horizontal.

Young leaf : Light purplish green ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets slightly curved adaxially ; central leaflet 16±0·4 cm. long and 4±0·1 cm. wide.

Petiole scar : Dark purple with green tinge.

Stem : Dark green with faint red stripes when young, silver grey when mature.

Flowers : Males and females appear in profusion, and almost simultaneously ; male calyx cream with pale alizarine pink shading ; female calyx neva green with faint alizarine pink lines ; stigma white ; ovary green with pink ridges.

Capsule : Antique green ; nectary coral red.

Tuber : Fat and long ; surface smooth, warm buff to apricot buff with occasional grey patches ; phelloderm light yellow ; flesh yellow.

Habit : Branching moderately low ; foliage moderate dense.

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* The first mentioned parent in every instance is the female.

MUh. 4

(MU. 41 × MU. 59)

Petiole : 20±0·5 cm. long, dark red at the ends, less deeply coloured towards the centre. sigmoid, horizontal, inclining and declining.

Young leaf : Purplish green ; midrib red.

Mature leaf : Dark green, large, commonly with 7 leaflets ; leaflets plane, with distal ends bending down ; central leaflet 15±0·2 cm. long and 4±0·1 cm. wide.

Petiole scar : Dark maroon.

Stem : Yellowish green when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males yellowish green with alizarine pink shading ; calyx of females neva green with alizarine pink shading ; stigma white ; ovary green with pink ridges.

Capsule : Apple to light green with purple wings ; nectary coral red.

Tuber : Of medium size ; surface warm buff to tawny brown, scaly ; phelloderm light yellow ; flesh yellow.

Habit : Branching low and frequent ; foliage dense.

MUh. 5

(MU. 51 × MU. 41)

Petiole : 27±0·4 cm. long, yellowish green, curved at the distal end, inclining and horizontal.

Young leaf : Dark green ; midrib light red.

Mature leaf : Dark green, of medium size, with usually 7 leaflets ; leaflets slightly curved adaxially, with distal halves bending down ; central leaflet 19±0·2 cm. long and 6±0·1 cm. wide.

Petiole scar : Dark green.

Stem : Bright green when young, wood brown when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males and females neva green with alizarine pink shading ; stigma white ; ovary purplish green.

Capsule : Apple green to light green with purple wings ; nectary carmine.

Tuber : Fat and long ; surface slightly scaly ; phelloderm white ; flesh white.

Habit : Branching high and infrequent ; foliage dense.

MUh. 7

(MU. 51 × MU. 41)

Petiole : 29±0·4 cm. long, carmine (colour deepest at the ends), irregularly shaped, inclining, horizontal and declining.

Young leaf : Yellowish green with faint tinge of purple ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets slighty curved adaxially, with distal halves bending down ; central leaflet 23±0·2 cm. long, and 6±0·1 cm. wide.

Petiole scar : Bordeaux purple.

Stem : Yellowish green with red stripes when young, silver grey when mature.

Flowers : Blooming of males and females simultaneous ; calyx of males and females cream with alizarine pink shading ; stigma white ; ovary green with pink shading and ridges.

Tuber : Of medium thickness, long ; surface somewhat scaly, tawny brown to warm buff ; phelloderm white ; flesh white.

Habit : Branching high and frequent ; foliage dense.

MUh. 8

(MU. 51 × MU. 41)

Petiole : 24±0·5 cm long, carmine (colour deepest at the ends), curved at the distal end, inclining and horizontal.

Young leaf : Purplish green ; midrib red.

Mature leaf : Dark green, large, commonly with 9 leaflets: leaflets broad, not divergent, with distal halves bending down ; central leaflet 20±0·3 cm. long, and 6±0·1 cm. wide.

Petiole scar : Dark yellow to dahlia purple.

Stem : Yellowish green with red stripes when young, wood brown when mature.

Flowers : Males and feamles appear in profusion and almost simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females neva green with alizarine pink shading ; stigma white ; ovary purplish green with pink ridges.

Capsule : Light green with pink wings ; nectary carmine.

Tuber : Long, of medium thickness ; surface scaly, tawny brown to kaiser brown: phelloderm white ; flesh white.

Habit : Branching high and infrequent ; foliage dense.

MUh. 9

(MU. 51 × MU. 41)

Petiole : 27±0·5 cm. long, reddish (colour deepest at the ends), sigmoid, alternately inclining and horizontal.

Young leaf : Light purplish green ; midrib yellowish green.

Mature leaf : Light green, of medium size, with commonly 7 leaflets ; leaflets adaxially concave in cross section, divergent, bending down at the tips ; central leaflet 19±0·4 cm. long and 5±0·1 cm. wide.

Petiole scar : Yellow to red.

Stem : Yellowish green when young, wood brown when mature.

Flowers : Both sexes bloom simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females cream externally and shaded alizarine pink internally ; stigma white ; ovary purplish green with pink ridges.

Capsule : Apple green to light green, with light pink wings ; nectary carmine.

Tuber : Fat and long ; surface scaly, tawny brown to kaiser brown ; phelloderm white ; flesh white.

Habit : Branching low and frequent.

MUh. 10

(MU. 41 × MU. 59)

Petiole : 29±0·5 cm. long, carmine (colour deepest at the ends), straight, inclining, horizontal and declining.

Young leaf : Purplish green ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets plane, with distal ends, bending down ; central leaflet 21±0·4 cm. long and 5±0·1 cm. wide.

Petiole scar : Dahlia purple.

Stem : Yellowish green with five red, shaded stripes when young, wood brown when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females with alizarine pink lines ; stigma white ; ovary green with pink ridges.

Capsule : Apple to light green ; nectary carmine.

Tuber : Of medium size ; surface scaly, kaiser brown to hazel brown ; phelloderm white ; flesh white.

Habit : Branching late and infrequent ; foliage moderately dense.

MUh. 11

(MU. 41 × MU. 59)

Petiole : 29±0·5 cm. long, carmine (colour deepest at the ends), slightly sigmoid, alternately inclining and horizontal.

Young leaf : Purplish green ; midrib yellow to red.

Mature leaf : Light green, of medium size, with commonly 7 leaflets ; leaflets slightly curved adaxially ; central leaflet 21±0·2 cm. long and 5±0·1 cm. wide.

Petiole scar : Bright purple.

Stem : Yellowish green when young, wood brown to silver grey when mature.

Capsule : Apple green to light green with pale pink wings ; nectary coral red.

Tuber : Of medium thickness and length ; surface smooth, warm buff to light buff with occasional grey patches ; phelloderm white ; flesh white.

Habit : Branching low and frequent ; foliage moderately dense.

MUh. 12

(MU. 41 × MU. 59)

Petiole : 27±0·6 cm. long, pale green with faint rose ring at proximal end and rose shading at curved distal end, horizontal, inclining and declining.

Young leaf : Purplish green ; midrib light green.

Mature leaf : Light green, of medium size, with commonly 7 leaflets ; leaflets adaxially concave in cross section ; central leaflet 19±0·3 cm. long and 5±0·1 cm. wide.

Petiole scar : Yellowish green.

Stem : Light green when young, wood brown when mature.

Flowers : Both sexes bloom almost simultaneously ; calyx of male cream with faint alizarine pink shading ; calyx of female with alizarine pink lines ; stigma pale pinkish white ; ovary green with pink ridges.

Capsule : Apple green to light green with bright pink wings ; nectary coral red.

Tuber : Fat and short ; surface scaly, kaiser brown to Hay's russet ; phelloderm white ; flesh white.

Habit : Branching moderately low ; foliage moderately dense.

MUh. 14

(MU. 59 × MU. 41)

Petiole : 34±0·6 cm. long, yellowish green, darker green at the ends, usually inclining, occasionally horizontal, distal end curved.

Young leaf : Bright green ; midrib light green.

Mature leaf : Dark green, medium-sized, with commonly 7 leaflets ; leaflets plane, divergent, bending down at the tips ; central leaflet 20±0·3 cm. long and 5±0·1 cm. wide.

Petiole scar : Dark green.

Stem : Bright green when young, silver grey when mature.

Flowers : Males and females appear in profusion, and almost simultaneously ; calyx of males and females neva green ; stigma white ; ovary light green.

Capsule : Apple green with light green wings ; nectary coral red.

Tuber : Of medium size ; surface smooth, warm buff ; phelloderm light yellow ; flesh yellow.

Habit : Branching low and frequent ; foliage moderately dense.

MUh. 16

(MU. 59 × MU. 41)

Petiole : 30±0·9 cm. long, yellowish green, red at the ends, irregularly shaped, inclining and horizontal.

Young leaf : Yellowish green ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets slightly curved adaxially ; central leaflet 20±0·3 cm. long and 5±0·1 cm. wide.

Petiole scar : Dark red with a tinge of green.

Stem : Bright green when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of male and female flowers neva green with light pink lines ; stigma white ; ovary bright green.

Capsule : Antique green with light green wings ; nectary carmine.

Tuber : Of medium size ; surface smooth, warm buff, with occasional grey patches ; phelloderm white ; flesh light yellow.

Habit : Height of branching variable ; foliage dense.

MUh. 17

(MU. 41 × MU. 51)

Petiole : 22±0·2 cm. long, carmine (colour deepest at the ends), slightly sigmoid, alternately inclining and horizontal.

Young leaf : Purplish green ; midrib light red.

Mature leaf : Dark green, large with commonly 7 leaflets ; leaflets broad, not divergent, with distal halves bending down ; central leaflet 19±0·2 cm. long and 6±0·1 cm. wide.

Petiole scar : Bright purple.

Stem : Light green with shaded stripes when young, wood brown when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females alizarine pink internally and cream externally ; stigma pale pinkish white ; ovary green with pink ridges.

Capsule : Light green to apple green, with light pink wings ; nectary carmine.

Tuber : Fat and long ; surface scaly, liver brown to hazel brown ; phelloderm white ; flesh white.

Habit : Branching high and late ; foliage dense.

MUh. 18

(MU. 51 × MU. 41)

Petiole : 25±0·3 cm. long, carmine, straight to sigmoid, alternately inclining and horizontal.

Young leaf : Light green with a faint tinge of purple ; midrib red.

Mature leaf : Dark green, large, with commonly 7 leaflets ; leaflets broad, slightly concave in cross section ; central leaflet 19±0·2 cm. long and 6±0·1 cm. wide.

Petiole scar : Bright purple.

Stem : Yellowish green with red stripes when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with faint alizarine pink shading ; ovary green.

Tuber : Of medium thickness, long ; surface smooth, warm buff to light buff, with occasional grey patches ; phelloderm white ; flesh white.

Habit : Branching low and frequent ; foliage moderately dense.

MUh. 19

(MU. 51 × MU. 11)

Petiole : 29±0·5 cm. long, pale green with faint rose ring at proximal end and rose shading at curved distal end, usually inclining, occasionally horizontal, sigmoid.

Young leaf : Purplish green ; midrib yellowish green.

Mature leaf : Light green, of medium size, with commonly 7 leaflets ; leaflets adaxially concave in cross section ; central leaflet 20±0·3 cm. long and 6±0·1 cm. wide.

Petiole scar : Yellowish green.

Stem : Yellowish green when young, wood brown when mature.

Flowers : Males few and abortive ; females more numerous ; calyx of males off-white with pink lines ; ovary green ; stigma white.

Capsule : Light green ; nectary carmine.

Tuber : Fat and short ; surface scaly, kaiser brown to russet brown ; phelloderm white ; flesh white.

Habit : Branching low and frequent ; foliage dense.

MUh. 20

(MU. 51 × MU. 41)

Petiole : 27±0·3 cm. long, carmine (colour deepest at the ends), slightly sigmoid, inclining, horizontal and declining.

Young leaf : Purplish green ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets adaxially concave in cross section, divergent, bending down at the tips ; central leaflet 19±0·3 cm. long and 5±0·1 cm. wide.

Petiole scar : Dark purple.

Stem : Bright green with light red shading when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with light alizarine pink shading ; calyx of female flowers neva green to cream with alizarine pink .lines ; stigma white ; ovary green with pink ridges.

Capsule : Antique green with pink wings ; nectary coral red.

Tuber : Fat and long ; surface smooth, warm buff to apricot buff ; phelloderm white ; flesh white.

Habit : Branching low and frequent ; foliage moderately dense.

MUh. 21

(MU. 59 × MU. 41)

Petiole : 24±0·6 cm. long, red (colour deepest at the ends), irregularly shaped, alternately inclining and horizontal.

Young leaf : Light green with a tinge of purple ; midrib red.

Mature leaf : Dark green, of medium size, with commonly 7 leaflets ; leaflets plane, bending down slightly at the tips ; central leaflet 17±0·2 cm. long and 5±0·1 cm. wide.

Petiole scar : Dark purple.

Stem : Bright green when young, silver grey when mature.

Flowers : Males and females appear in profusion and almost simultaneously ; calyx of males cream with alizarine pink shading ; calyx of females neva green with alizarine pink shading ; stigma white ; ovary green with pink ridges.

Capsule : Apple green to light green ; nectary carmine.

Tuber : Fat and short ; surface smooth, warm buff to apricot buff with occasional grey patches ; phelloderm light yellow.

Habit : Branching early and low ; foliage moderately dense.

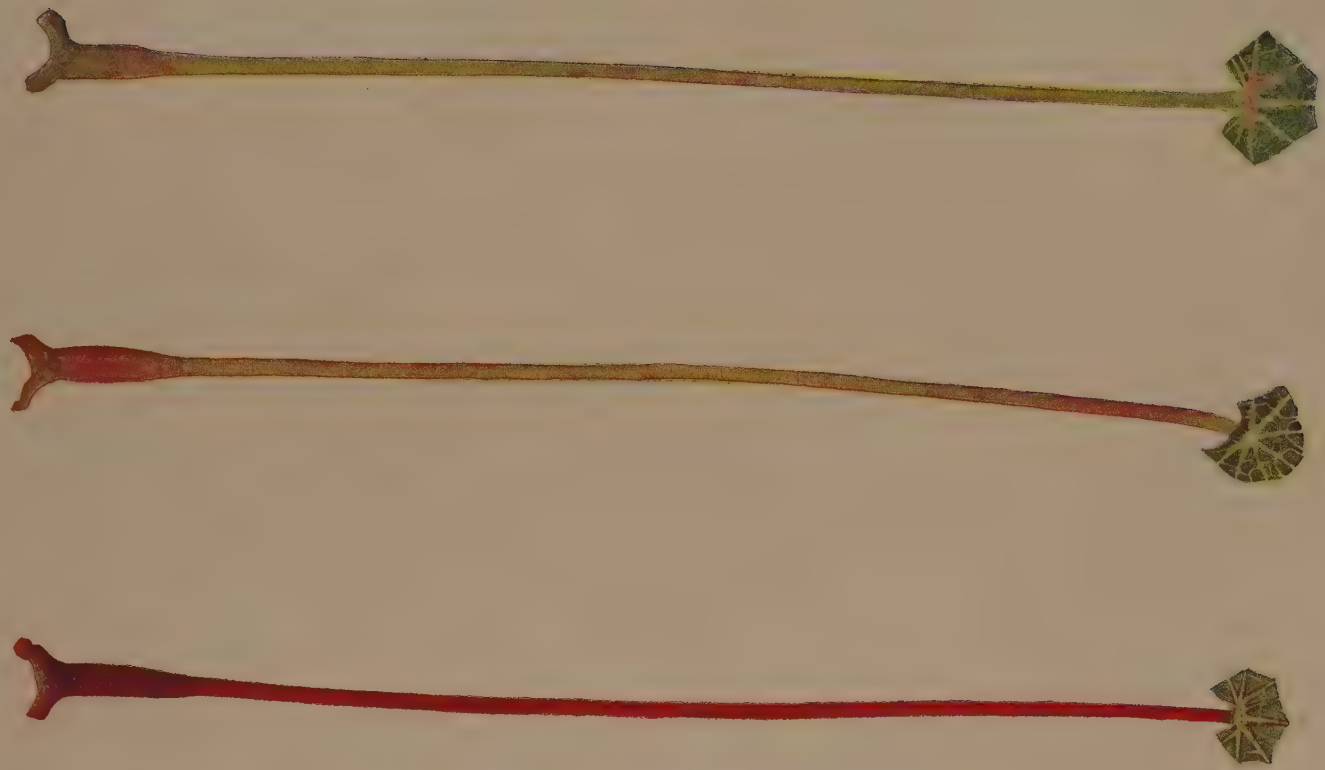
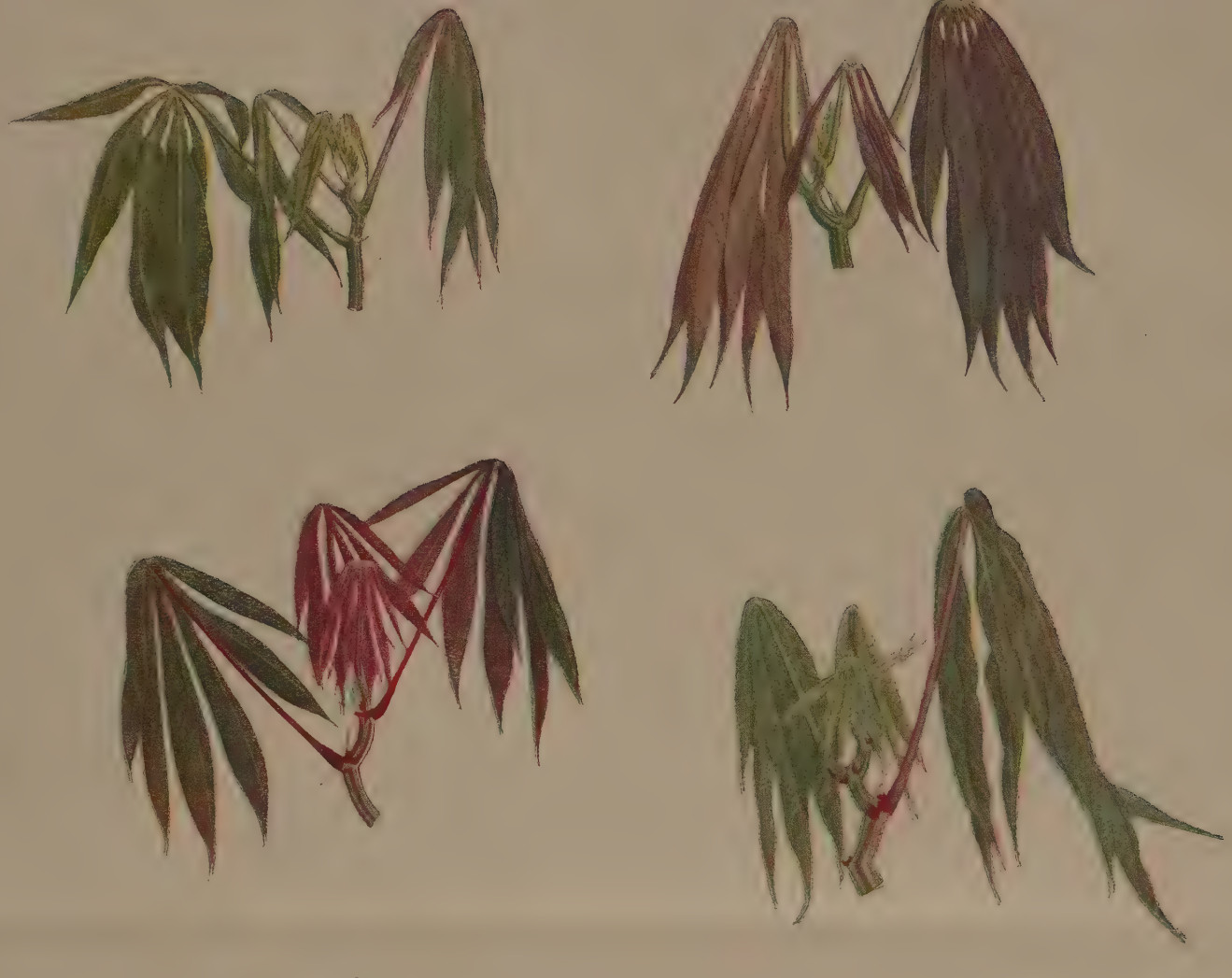


PLATE I. Petiole Colour in Races of *Manihot Utilissima* Pohl.



c b[1]

PLATE II. Colour of the Young Leaf in Races of *Manihot Utilissima* Pohl.

PLATE III. Colour of the Young Stem in Races of *Manihot Utilissima* Pohl.

PLATE IV. Colour of the Mature Stem in Races of *Manihot Utilissima* Pohl.

d e f

PLATE V. Colour of the Surface of the Tuber in Races of *Manihot Utilissima* Pohl.

a b c

PLATE VI. Colour of the Tuber Phelloderm in Races of *Manihot Utilissima* Pohl.

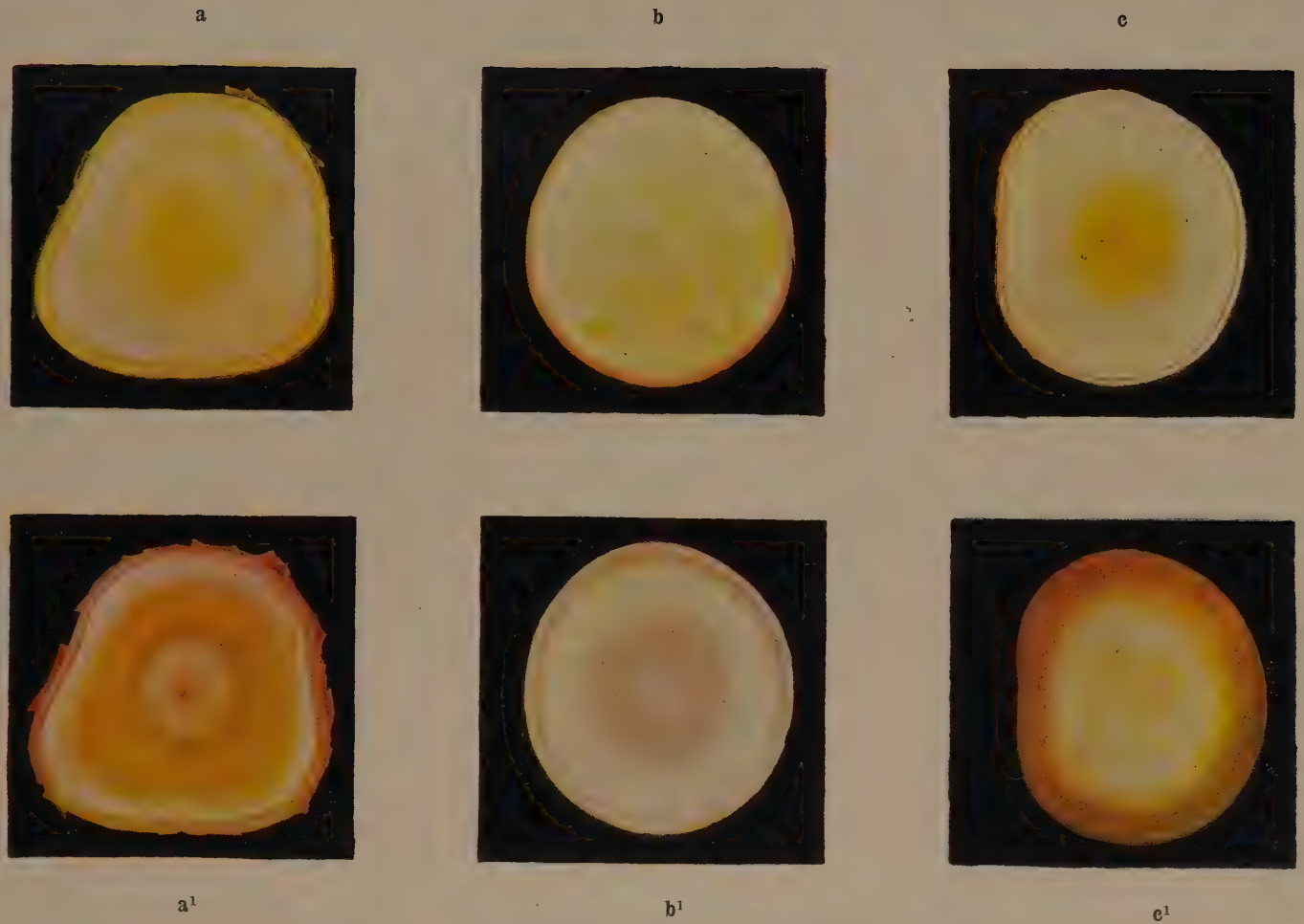


PLATE VII. Colour of the Tuber Flesh in Races of *Manihot Utilissima* Pohl.

A NOTE ON THE FACTORS AFFECTING THE ECONOMIC USE OF TRACTORS IN PLOUGHING AND HARROWING (PADDY) LAND

BY

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THIS note is the result of an investigation based on material obtained during September, 1946–January, 1947, when tractors were employed in Kalmunai District, E. P., for the extensive ploughing and harrowing of paddy land. The Scheme was worked departmentally and selected tracts of land were ploughed and harrowed by tractors drawing mechanical implements. The work was carried out on dry land. In return for the work done on his land, each land owner was required to pay to the Government two bushels of paddy per acre of land ploughed and harrowed, while the Government bore all the costs of the Scheme. The value of two bushels of paddy in money was Rs. 12 and although the Scheme was worked without any intention of profit to Government, but merely to stimulate increased food production, it was obviously necessary, and of interest, to determine the actual cost to Government of the work done per acre of land. Of greater interest and value would be the knowledge of how this cost could be controlled by regulating the efficiency of working in such a way as to ensure that any such Scheme could be economically organised, and this investigation was undertaken with a view to ascertaining the relation that must exist between this cost and the efficiency of working. The following material was obtained during the work in Kalmunai, and is based on work done in ploughing and harrowing about 7,000 acres of land by a number of tractors varying from 8 to 20 :

Month.	Total cost of Scheme.	Average cost per machine.	Average acreage per machine.	Av. hours worked per machine.	Av. cost per acre.	Av. acreage worked per hour.
	Rs. c.	Rs. c.			Rs. c.	
September, 1946 ..	7,037 47	.. 703 75 ..	28·0 ..	73·1 ..	25 13 ..	·38
October ..	8,137 52	.. 697 30 ..	87·8 ..	197·0 ..	7 94 ..	·45
November ..	9,710 46	.. 778 70 ..	113·6 ..	227·3 ..	6 85 ..	·50
December ..	10,447 87	.. 612 30 ..	76·0 ..	176·3 ..	8 6 ..	·43
January, 1947 ..	10,104 27	.. 674 70 ..	58·7 ..	146·0 ..	11 50 ..	·40

As has to be expected, the average cost of ploughing and harrowing an acre of land appears to be intimately connected with the average rate of ploughing and harrowing an acre, the former decreasing as the latter increases.

In what follows, the relation that obviously exists is worked out analytically and then tested by application to results obtained.

4——J. N. A 82344 (9/48)

2. **THEORY :**

Let C be the cost incurred per machine during a period of time T in which a Scheme is in operation for tractor ploughing and harrowing land. During this period the machines will actually work in the field for only a portion of the time, say, t which is a fraction of T and can be written $t = \frac{1}{n} T$ ———— (1) where n is a number. Let a total acreage A be ploughed and harrowed during this working time t.

Now the cost C is composed of two items

(A) Establishment charges, say C_E.

and (B) Working costs, say, C_A.

C_E, being made up of wages and other items of a similar nature, will depend only on T and can be written $C_E = K_1 T$ ———— (2) where K_1 is some constant.

Similarly C_A, the working cost, being the cost of fuel, oil, &c., will depend on the time spent in working in the field, and may be written $C = K_2 t$ ———— (3) where K_2 is another constant.

Then the total cost C may be written

$$C = K_1 T + K_2 t$$

or $C = K_1 n t + K_2 t$, Since $T = nt$.

Dividing by A this becomes

$$\frac{C}{A} = \frac{t}{A}(K_1 n + K_2) \text{ ———— (4).}$$

In this equation K_1 and K_2 are constants, and if we assume that n is also constant, *i.e.*, that the time spent in the field, t, is a fixed proportion of the duration of the Scheme, T, or in other words, that the daily " working shift " is fixed, the equation becomes

$\frac{C}{A} \cdot \frac{A}{t} = K$ ———— (5) where K is a constant equal to $(K_1 n + K_2)$, and $(\frac{C}{A})$ and $(\frac{A}{t})$ are variables. This equation represents a hyperbola with the axes as asymptotes. The relation between the cost of ploughing and harrowing an acre of land and the rate of doing it is thus hyperbolic.

3. **APPLICATION OF THEORY TO RESULTS :**

For convenience, the value of $\frac{C}{A}$ and $\frac{A}{t}$ quoted in para. 1 are reproduced, as well as the values of $(\frac{C}{A} \cdot \frac{A}{t})$ or $(\frac{C}{t})$.

Month	C/A	A/t	C/t (=K)
September ..	25·13	·38	9·6
October ..	7·94	·45	3·5
November ..	6·85	·50	3·4
December ..	8·06	·43	3·5
January ..	11·50	·40	4·6

A glance at these figures shows that except for the months of September and January, the value of C/t during the other months was remarkably constant, as the theory indicates should be the case. The reasons for the variations in September and January are explained later.

It is proposed to test the validity of the theory derived by plotting a theoretical curve giving arbitrary values to the independent variable A t, and seeing how the theoretical curve fits the experimental results. For this purpose the value of K is taken to be the average value of C t during the months October–December, when C t was very nearly constant. This value is 3·48. We can now give values to A t varying, say, from 0 to ·7 and compute the corresponding value of C A from the relation

$$\frac{C}{A} \cdot \frac{A}{t} = 3{\cdot}48$$

Thus when $\frac{A}{t} =$	0	·1	·2	·3	·4	·5	·6	·7
$\frac{C}{A} =$	∞	34·8	17·6	11·6	8·7	7·0	5·8	5·0

Plotting these values of $\frac{C}{A}$ used $\frac{A}{t}$ we obtain the curve shown in the annexe to this note, which is a hyperbola.

If we now plot the experimental results quoted at the beginning of this paragraph we obtain the points marked A, B, C, D, E. Except for the points A and E, which relate to the months of September and January respectively, the other points B, C, and D are seen to fall almost perfectly on the curve, thus demonstrating the validity of the theory.

The discrepancies observed in the points A and E are easily explained. In the theory leading to the equation $\frac{C}{A} \cdot \frac{A}{t} = K$ we assumed that n was constant, *i.e.*, that the ratio $\frac{t}{T}$ was constant or in other words that the working shift was fixed. During the month of September, at the commencement of the Scheme, it took some time for the necessary organisation to be set up, and things to get settled. During this time the tractors did very little work in the field, and thus the ratio $\frac{t}{T}$ was not the constant value it assumed in succeeding months when the machines worked a constant shift daily. This fact was responsible for throwing the point A outside the curve drawn by assuming K, or $(K_1 n_1 + K_2)$, to have the value obtained during October, November, and December. A similar up-set occurred in January, which was responsible for the discrepancy in the point E: in that month the machines developed mechanical defects which seriously interfered with work in the field and made it impossible to maintain the constancy of t/T.

4. PRACTICAL VALUE OF ANALYSIS:

The first use to which this investigation was put was to determine the rate of ploughing and harrowing an acre of land required to keep the cost of this work below the amount of Rs. 12 recovered from the land owner—From the curve it will be seen that to keep the cost below Rs. 12 per acre,

the machine must plough and harrow at least approximately ·3 acres per hour, *i.e.*, if the machines work a 10 hour shift per day, they should each plough and harrow at least 3 acres per day. The output required to keep the cost down to any other value can similarly be found from the curve.

From the nature of the curve, the cost of working an acre of land is seen to increase rapidly when the rate of working decreases below a certain point. By regulating the rate of working we can thus control the cost of working at any desired value.

5. **CONCLUSION :**

It would have been observed that the experimental data on which this investigation was based consisted of average values for an average machine. This was unavoidable for the following reasons :

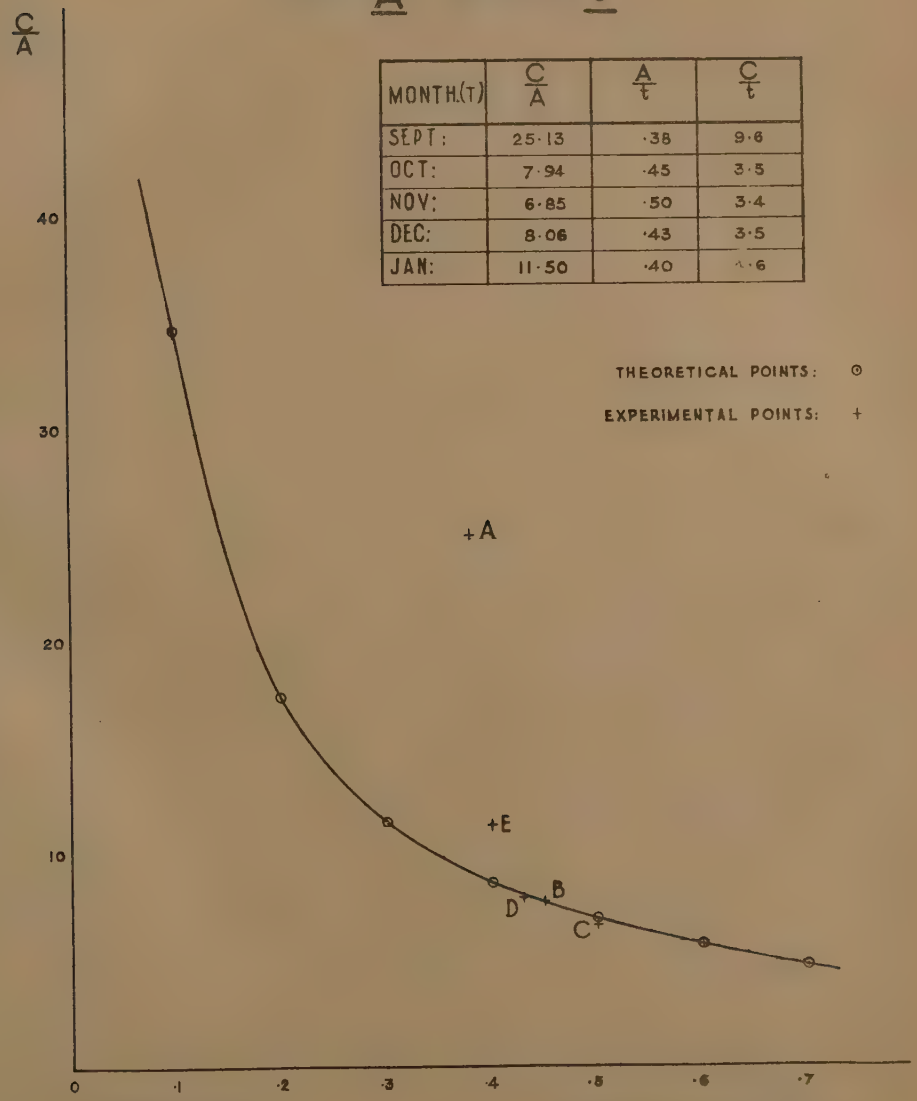
(*a*) A variety of tractors was used with a variety of implements depending on the nature of the soil ; the performance of each machine was thus not the same at all times, nor was there exact correspondence between one machine and another. The tractors used were D2s, D4s (track tractors), and Internationals, wheel and track types ; the implements were of three types, International, Sunshine Vertical and Allis Chalmer. The approximation resulting from the use of average values, by treating all machines as being identical, does not in any way vitiate the principles applied in the analysis nor will it appreciably affect the conclusions as far as numerical values go.

(*b*) With the staff available it was impossible to keep a record of the performance of every individual tractor working with a particular type of implement.

Notwithstanding these approximations, the results obtained are sufficiently accurate to enable any Scheme using tractors to be economically planned and, at least, they indicate the principles to be borne in mind if tractors are to be used in any large-scale Scheme with advantage. By observance of these principles, it was possible, during the work on the 7,000 acres of paddy land in Kalmunai District, to keep the cost per acre down to a value between Rs. 6 and Rs. 8 per acre (except during the months of September, 1946, and January, 1947, when the cost was unavoidably higher for reasons already explained), while recovery for the work done was at the rate of Rs. 12 per acre, thus showing a profit of the order of Rs. 4 per acre. Depreciation of the machines and implements has not been allowed for in the results obtained, but these values can quite easily be ascertained from the manufacturers and provided for in a more accurate survey of the problem. No more than a very brief survey was possible on this occasion, as the machines were detailed for work in Kalmunai for only a very short period of five months, and this period was quite insufficient for a comprehensive study of the problem. For instance it was assumed in the theory that the cost of working was directly proportional to the time worked ; how far this assumption is correct in practice can be ascertained only by a detailed study of this particular aspect of the problem, which will require observations of a sufficient number to permit of their analysis.

GRAPH SHOWING THE VARIATION OF $\frac{C}{A}$ WITH $\frac{A}{t}$

MONTH.(T)	$\frac{C}{A}$	$\frac{A}{t}$	$\frac{C}{t}$
SEPT:	25·13	·38	9·6
OCT:	7·94	·45	3·5
NOV:	6·85	·50	3·4
DEC:	8·06	·43	3·5
JAN:	11·50	·40	4·6



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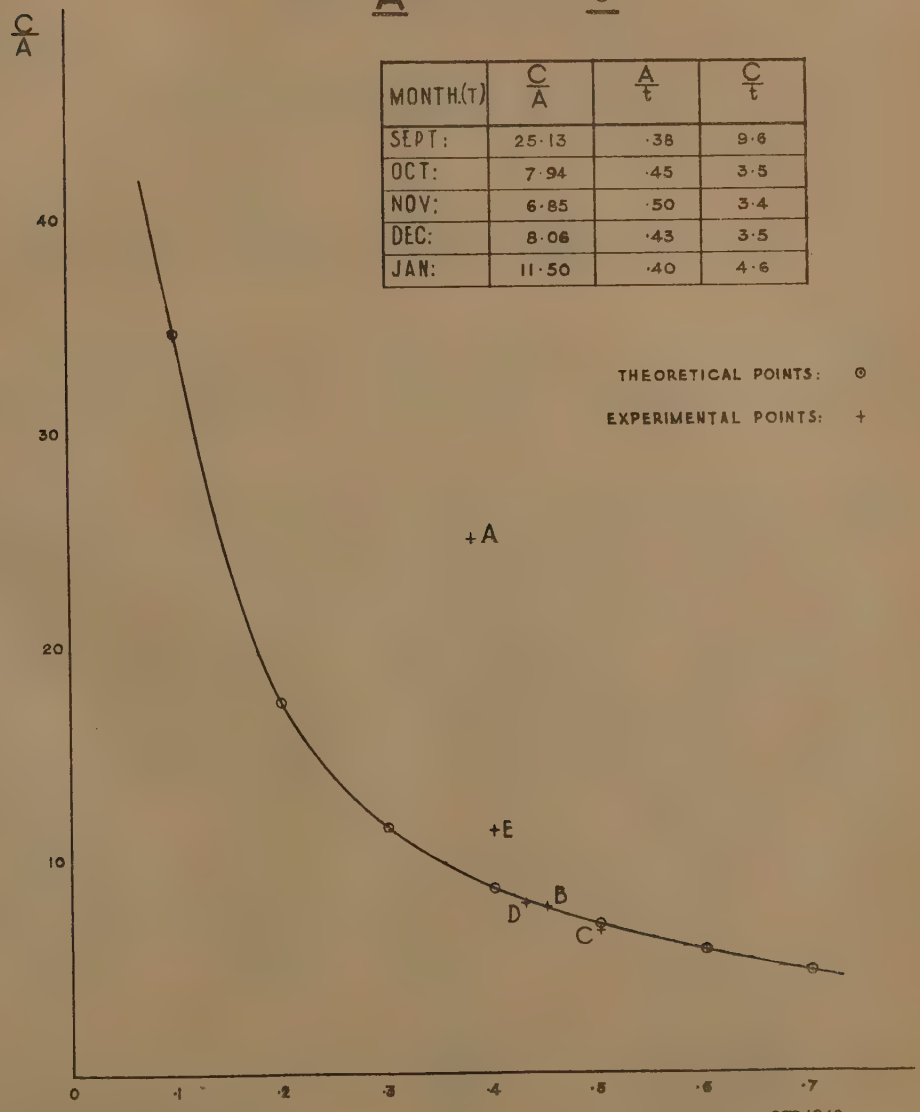

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A NOTE ON BANDAKKA (HIBISCUS ESCULENTUS, L.) AS A SOURCE OF EDIBLE OIL

BY

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K. S. MARKLEY and F. G. Dollear (1) have recently directed attention to the potentialities of *H. esculentus* as an oilseed crop in the Southern and South-Western States of the U. S. A.

Bandakka is cultivated throughout Ceylon as a vegetable (2, 3, 4), but has not been considered as an oilseed. We have examined a sample of ripe seed from plants grown at Bandirippuwa Estate, Lunuwila, and our results are tabulated below, with figures from the literature for comparison.

It will be seen that in oil content and general composition our sample did not differ materially from American-grown seeds. Nevertheless, we do not consider that Bandakka is worth consideration as an oilseed crop in Ceylon. Solvent extraction would be necessary for recovery of the oil, unless the seeds are separated into seed-coats and kernels, and only the latter pressed. This separation is not a simple matter (1). If new sources of vegetable oils, supplementary to coconut, are to be developed in Ceylon, we should regard the most promising annual crops as being gingelly, groundnut and sunflower.

Experimental.—Ten dry seed pods (total weight 134·5 gms.) gave 775 seeds weighing 51·5 gms. (38·3 per cent.). This seed weight corresponds to approximately 6,830 seeds to a lb.

TABLE I.a.—COMPOSITION OF UNDECORTICATED BANDAKKA SEED.

Per Cent.	Present (Ceylon) Sample.	Range of figures quoted by Markley and Dollear (1).
Moisture	11·75 ..	5·67–12·17
Fat	15·07 ..	12·8 –22·03
Protein (N x 6·25)	16·86 ..	16·12–22·86
Crude Fibre	22· 7 ..	19·68–28·35
Ash	3·76 ..	2·11– 6·25

TABLE I.b.—ASH CONSTITUENTS OF CEYLON BANDAKKA SEEDS.

	As Per Cent. of ash.	Per Cent. of whole original seeds,	Literature figures (5),
Ca O	5·3 ..	0·198 ..	0·155–0·276
K_2 O	16·4 ..	0·617 ..	—
$P_2 O_5$	33·2 ..	1·250 ..	—

The oil (15·07 per cent.) extracted by ether was greenish-yellow in colour, and had a strong odour reminiscent of olive oil. It had the following characteristics :

TABLE II.—PROPERTIES OF BANDAKKA SEED OIL.

	Present Sample.	Figures of Markley and Dollear (1),	Jamieson and Baughman (6).
Iodine Value (Wijs, 1 h.) ..	87·2 ..	91·1 ..	93·2–100·3
Saponification Value ..	201·1 ..	194·6 ..	195·2–195·5
Free fatty acid (as oleic per cent.) ..	2·4 ..	1·4 ..	0·68–2·84
Unsaponifiable (per cent.) ..	2·4 ..	1·1 ..	0·37

Both Jamieson and Baughman (6) and Halverson and Naiman (5) report that okraseed oil gives the Halphen reaction characteristic of cotton seed oil and some other oils of Malvaceous species. Neither our sample nor its derived fatty acids gave this reaction.

The oil-free extracted meal could be separated on a 50-mesh sieve into 34 per cent. of fine meal (almost free from seed coats) and 66 per cent. of coarse meal mostly consisting of seed coats. The former contained only 3·54 per cent. of crude fibre, compared with 51·21 per cent. in the coarse fraction (both figures calculated on the dry weight).

Since the above paper was completed we have received the paper by R. Singh and S. Dutt (*Indian Soap J.*, 1947, *13*, 99–101). These investigators found 14·82 per cent. of oil in Indian seeds. The oil had Iodine Value, 77·95 ; sap val., 194·4, acid value 12·14, unsap. per cent. 1·23. They report that the mixed acids (titre, 39·50) contained myristic 0·76, palmitic 23·02, stearic 4·98, oleic 49·29 and linoleic acid 22·04 per cent. The unsaponifiable matter contained sisosterol.

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FEEDING TRIALS WITH THE SENSITIVE PLANT—MIMOSA PUDICA

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AND

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THE sensitive plant, *Mimosa pudica*, has always been considered as a noxious weed in Ceylon. It has been the practice therefore to eradicate it from plantations and pasture areas wherever it occurs. Efforts to eradicate or keep down the growth of the plant have been annually recurring for many years. Very large sums of money have been spent and labour utilised both by private land owners and on Government properties. It cannot be said however that any marked success has attended these efforts.

Experience in other tropical countries and particularly in Fiji have shown that the sensitive plant is palatable to cattle and is highly nutritive. A. Despeissis, (1) at one time Director of Agriculture in Fiji wrote: "No account of Fiji would be complete without reference to the sensitive plant *Mimosa pudica* which is spread wherever cattle are found. It possesses the one very serious disadvantage that it is prickly and rough on barefooted Fijians and Indians and even on stock unless it is kept in order by feeding down and occasional burning. Its redeeming features are its hardiness, great feeding value, producing firm meat and increased flow of milk. On coconut estates it increases the nitrogenous content of the soil and incidently, the copra yield".

Sir Maynard Hedstrom (2) stated: "I was very apprehensive when I saw the gradual decrease of para grass and the increase in the sensitive plant in the pastures but I have become reconciled to that condition—the sensitive plant stands very heavy feeding, cattle take to it quite readily and at present a very large percentage of the butter fat produced at the Fiji Pastoral Company at Navua is from sensitive".

As long ago as 1921, C. H. Wright, Government Chemist, Fiji (3) conducted analysis of the plant which he reported on as follows:—

"*Sample 54.*—The sample was obtained from the plant in flower. It consisted of the ends of young stems with leaves and flowers such as cattle would eat. The sample contained:—

Water.	Protein.	Carbohydrate.	Fibre.	Fat.	Ash.
74·9	5·5	9·0	8·2	0·8	1·6

"*Sample 85.*—This was taken from a plant which had not been grased. It consisted of the whole plant above the ground, including flowers and fruits. The sample contained:—

Water.	Protein.	Carbohydrate.	Fibre.	Fat.	Ash.
65·7	3·8	13·9	14·4	0·6	1·6

The Manual of Green Manuring, Ceylon (1931), gives the analysis of the whole plant which Dr. Koch, Chemist, Department of Agriculture, has computed to compare with the above analysis as follows :—

Water.	Dry matter.	Protein.	Non-protein.	Ash.
69·4 ..	30·6 ..	1·8 ..	27·23 ..	1·4

From the practical feeding point of view, the first analysis gives the better picture because cattle when grazing on the plant, pluck and consume the individual tender shoots, the woody fibrous portion of the plant being consumed only by accident or when pasture is extremely scanty. To the human palate the flavour of the plant is agreable and is highly mucilagenous. It is similar in these respects to some other feeds which are well liked by cattle.

Ripperton and Hosaka are quoted (4) as having stated " The most widely distributed (in Hawaii) forage legume is the sensitive plant *Mimosa Pudica*. Its importance is due to the fact that no other suitable legume is available. "

In Fiji where one of the authors has had much experience, the plant grows prolifically and has the reputation of producing well-conditioned fat cattle of firm flesh. Cattle fattened on sensitive plant keep their condition better than those fattened on succulent grass and stand the hardships of overlanding and transportation better than do other cattle. For milk production the sensitive plant is also valued, since it helps to provide a well balanced ration high in protein content. Butter produced from milk of cows fed on the plant is of a rich yellow colour, indicative of a plentiful supply of carotene in the diet.

The plant has the disadvantage of being armed on the stems with thorns which cause injury to the feet of labourers working on fields where it occurs and on that account is unpopular with labourers. In coconut plantations the plant is a good cover crop and a source of nitrogen. For the above mentioned reason however its presence on coconut plantations in Ceylon is not favoured. The difficulty in regard to labour has been overcome in Fiji by providing them with sandals made from discarded rubber motor car tyres.

In view of the conflicting opinions in regard to the value or absence of value of the sensitive plant in pasture the Director of Agriculture in Ceylon authorised the experiment described in this paper. The Research and Experiments Committee of the Department therefore approved of the plan as set out as follows :—

PASTURE FEEDING TRIAL (MIMOSA PUDICA)

Plan of Experiment

Objects.—(*a*) To compare the feeding value of pasture containing natural growth of *Mimosa pudica* with that of pasture from which this plant has been eradicated.

(*b*) To compare the cost of maintenance of such fields.

Centre.—Polonnaruwa.

Officer-in-charge.—Specialist in Animal Husbandry (P). The Manager, Cattle Farm, Polonnaruwa, was responsible for conducting the experiment under the direction of the Specialist in Animal Husbandry.

Treatments.—Pasture with and without *Mimosa pudica*. Two replications of each.

Experimental details.—Two fields each 20 acres in extent, containing an abundant growth of naturally occurring *Mimosa pudica* were selected. In selecting the fields, care was taken to ensure that there was sufficient shade available within the area. An assured supply of water was provided. Each field was divided into two blocks, the Mimosa being removed by hand weeding from two blocks leaving grass and other naturally occurring legumes of pasture. The other two blocks were maintained with the Mimosa and grasses on it.

The experiment was started one month after preparing the fields so that the grass was able to re-establish itself in the vacant spaces caused by the removal of Mimosa.

It was originally planned that during the period of the trial the paddocks were to be mown by machine. No mowing machine could be obtained however, so that all weeding was done by hand. The period of the trial was one year.

Thirty two yearling male cattle of one breed and of approximately equal size and weight were selected and divided into four herds of eight each, by alternate selection by two selectors. Lots were drawn to allocate each herd to the paddock. Each animal was marked in a distinctive manner.

Each herd was maintained constantly night and day on its own paddock without rotational grazing and without additional feeding of any sort. They were however removed at regular intervals for dipping and for weighing, and returned to the paddock immediately after.

The experiment was set in hand on September 28, 1946, when a commencement was made in the preparation of the fields. On October 26, 1946, thirty-two pure-bred Red Scindi bulls, each about two years old were selected for the experiment. These were all dosed with standard copper and arsenic mixture for the removal of worm parasites.

The thirty-two animals were then divided into four approximately equal groups, one group for permanent location in each field. A preliminary weighing of individual animals which had been already marked for identification was made on October 29, 1946, the date on which the groups were allocated to their paddocks.

From that date onwards the experiment proceeded according to plan which was well maintained with the following exceptions; animals numbered 19 and 149 suffered from three days fever in November, 1946. On the night of December 25, 1946, wild elephants in a joyful mood invaded the farm and broke the fences of paddocks three and four so that, on the day after Christmas the inmates of these two fields enjoyed temporary freedom; one bull from each field was castrated on December 28, 1946, whilst

Foot and Mouth disease occurred in February. The only other untoward event was the death on June 20, 1947, of calf No. 136. The cause of death was due to parasitism.

Monthly weighings were carried out on nine occasions. The weighings were missed one month on account of Foot and Mouth disease and for three other months the weighing balance was out of order. A full record of weighings is given in table I. in the Appendix.

The cost of labour used in keeping the Mimosa-free paddock free of both Mimosa and weeds was Rs. 205·40, whilst the cost of weeding the paddocks on which the Mimosa remained was Rs. 102·70. For the purpose of the experiment the animals were given a valuation as for beef at twenty-five cents per lb. live weight.

The results of the feeding trials are set out in Table II.

Observations:

	Lb.	Value. Rs. c.
Total weight gained by 16 animals in the mimosa paddocks ..	4373· ..	1,093 25
Total weight gained by 15 animals in mimosa-free paddocks ..	3008· ..	752 0
Average weight gained by each animal in the mimosa paddocks ..	273·3 ..	68 33
Average weight gained by each animal in the mimosa-free paddocks..	200·5 ..	50 12

	Mimosa Rs. c.	Mimosa-free Rs. c.
Value of increased weight	1,093 25..	752 0
Deduct cost of maintenance	102 70..	205 40
Difference	990 55	546 60

Mean difference (assuming zero gain for animal No. 128).
= 72·1
t = 2·79
1 Per Cent. point = 2·75 (29 D. F.)

The experiment has demonstrated that the sensitive plant improved the value of the pasture under the conditions of the trial. The average increase in weight per animal of the sixteen in the Mimosa paddocks exceeded that of the average of the fifteen in the Mimosa-free paddocks by seventy-two pounds. The value of the additional gain in weight is Rs. 288·00, while Rs. 103·00 was saved in weeding costs ; a total gain of Rs. 391·00.

Apart from the purely scientific aspects of the experiment, some practical points of interest to the farmer were demonstrated. Thirty-two more than half-grown bulls were maintained entirely on forty acres of pasture without supplementary feeding for over a year and without any rotation of pasture. One animal died and one failed to thrive. The remainder of the animals grew normally. In the field they presented a pleasing picture of fat sleek cattle. The experiment was a good demonstration of field management without rotation but with selective weeding. The fields looked well throughout the year.

Our thanks are due to Dr. F. Chandraratna, Botanist, for calculating the statistical significance of the experiment.

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TABLE I.

Records of Weighings

Paddock No.		Bull No.	Dates of Weighings 29/10/46	6/12/46	7/1/47	4/3/47	1/4/47	3/8/47	5/9/47	7/10/47	4/11/47	Diff in Wght.
3	No Mimosa	164	338	397	409	407	404	566	602	668	671	333
		19*	384	394	412	415	419	532	545	560	566	182
		41	390	437	473	468	478	549	562	577	574	184
		82	356	407	407	398	402	572	632	674	676	320
		94	436	499	508	513	522	609	656	650	650	214
		52	382	444	485	473	479	614	635	664	668	286
		93	391	453	475	471	468	604	616	658	652	261
		96	311	347	348	346	357	484	504	552	559	248
4	Mimosa.	137	340	397	434	432	436	614	618	646	657	317
		148	357	410	432	435	441	579	603	608	614	257
		28	429	471	511	513	521	649	672	672	676	247
		183*	350	389	404	410	408	520	535	562	560	210
		49	396	417	464	458	460	590	616	668	671	275
		138	384	442	468	471	477	618	633	689	692	308
		142	275	404	448	454	460	656	672	700	706	431
		77	389	438	480	483	496	631	652	696	697	308
5	Mimosa.	161	414	471	464	460	467	610	623	644	648	234
		56	391	450	488	485	488	622	634	668	666	275
		15	404	434	453	465	460	562	572	606	614	210
		203	332	369	372	376	385	507	519	548	551	219
		81	394	422	443	446	447	612	644	682	687	293
		185*	368	392	410	416	421	578	588	592	607	239
		126	329	377	391	388	398	531	546	584	591	262
		168	349	418	428	436	441	607	626	632	637	288
6	No Mimosa.	133	361	423	426	429	438	527	537	538	539	178
		149	404	457	452	455	463	591	610	613	615	211
		130	312	354	353	361	366	476	488	484	491	179
		48*	361	404	384	390	371	418	431	434	442	81
		114	387	450	445	442	447	551	575	584	590	203
		198	370	429	415	410	418	493	505	518	508	138
		128	363	362	348	315	342	277	308	362	353	—10
		136	378	405	410	418	404	Died 30/6/47				

* Castrated.

Monthly weighings missed :—

February—Owing to Foot and Mouth disease.

May, June and July—Weighing machine out of order.

TABLE II.

Treatment.	Field No.	Bull No.	Weight at start. lb.	Value at start. Rs. c.	Weight at finish. lb.	Value at finish. Rs. c.	Difference in weight. lb.	Value of increased weight. Rs. c.
No Mimosa	3	164	338	84 50	671	167 75	333	83 25
		19*	384	96 0	566	141 50	182	45 50
		41	390	97 50	574	143 50	184	46 0
		82	356	89 0	676	169 0	320	80 0
		94	436	109 0	650	162 50	214	53 50
		52	382	95 50	660	167 0	286	71 50
		93	391	97 75	652	163 0	261	65 25
		96	311	77 75	559	139 75	248	62 0
			2988	747 0	5016	1,254 0	2028	507 0
Mimosa	4	137	340	85 0	657	164 25	317	79 25
		148	357	89 25	614	153 50	257	64 25
		28	429	107 25	676	169 0	247	61 75
		185*	350	87 50	560	140 0	210	52 50
		49	396	99 0	671	167 75	275	68 75
		138	384	96 0	692	173 0	308	77 0
		142	275	68 75	706	176 50	431	107 75
		77	389	97 25	697	174 25	308	77 0
			2920	730 0	5273	1,318 25	2353	588 25
Mimosa	5	161	414	103 50	648	160 0	234	58 50
		56	391	97 75	666	166 50	275	68 75
		15	404	101 0	614	153 50	210	52 50
		203	332	83 0	551	137 75	219	54 75
		81	394	98 50	687	171 75	293	73 25
		185*	368	92 0	607	151 75	239	59 75
		126	329	82 25	591	147 75	262	65 50
		168	349	87 25	637	159 25	288	72 0
			2981	745 25	5001	1,250 25	2020	505 0
No Mimosa	6	133	361	90 25	539	134 75	178	44 50
		149	404	101 0	615	153 75	211	52 75
		130	312	78 0	491	122 75	179	44 75
		48*	361	90 25	444	110 50	81	20 25
		114	387	96 75	590	147 50	203	50 75
		198	370	92 50	508	127 0	138	34 50
		128	363	90 75	353	88 25	–10	loss 2 50
		136	Not taken into account as it died during the trials					
			2558	639 50	3538	884 50	980	245 0

* Castrated during the trial.

SILAGE MAKING AT THE BATA-ATA FARM, SOUTHERN PROVINCE

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AND

J. I. SENEVIRATNE,

FARM MANAGER, BATA-ATA

INTRODUCTION

CONSIDERABLE difficulty is experienced at the above farm in providing sufficient succulent feed during the long annual drought periods, to the livestock that are admitted to the Board and Lodging Scheme of the above farm by which village cows, she-buffaloes and she-goats are cared for and sired by several proved breeds.

An attempt was therefore made in silage making, whereby the plentiful green fodder grasses which were available during the rainy months were conserved in a pit silo, thus improvising a method of supplying a succulent feed to the animals by way of silage, during the lean months of drought, when natural pasture is scarce, dry, unpalatable and lacking in nutritive qualities.

SILAGE

Feed like maize, sorghums, fodder grasses and leguminous crops, such as, lucerne and clover, normally fed to farm animals, when preserved in a succulent state in the absence of air is called silage, as opposed to hay or dry fodder which is feed preserved in a dry condition. If the material needed for silage making is raised exclusively in the farm, it provides the most economically produced succulent feed for farm animals to tide over times of scarcity. It has also the further advantage in that, a crop like maize, sorghum, green gram or cowpea doomed to failure through insect attack, disease or drought could be advantageously used for silage making.

When green or semi-green fresh material is heaped or interned, respiration of green tissues assisted by plant enzymes takes place and a process of fermentation with a rise of temperature occurs, provided air is excluded from the mass. The chief change that takes place in this process of curing is the breaking down of the complex substances like sugar and to a lesser extent protein compounds in the ensiled material and converting them into simpler organic compounds as lactic, acetic and amino acids, giving the silage a distinct acid smell.

Over-matured or withered material when ensiled develops moulds and an inferior silage known as " mouldy " or " musty " silage is the result. Immature, very soft succulent material cakes hard, prevents heating on curing and develops an objectionable smell and is known as " sour " silage. " Acid " silage is the best.

CONSTRUCTION OF THE SILO

Taking into consideration the climatic and weather conditions prevalent in the area and the capital expenditure involved, the pit type of underground silo was considered the most suitable.

A rectangular pit, 30 feet long, 6 feet broad and 8 feet deep was excavated on an elevated spot in the farm. A spacious, open cadjan shed, with broad eaves was erected over the pit. The drip was about 6 feet away from the pit and a drain was provided right round the shed to keep off any storm water and lead away the rain water from the roof.

The sides of the pit were shaved clean to plumb, removing all bumps and hollows as a good finish to the walls of the silo is absolutely essential in order to facilitate even packing and to help the material to sink evenly without obstruction, when settling of the charge takes place during the process of curing.

CHARGING THE SILO

Guinea and Napier grass cut at the stage normally used for fodder were utilized for the purpose. The grass cut during the morning session was charged the following morning, while the afternoon's cut was used the following afternoon, as partly withered material was easy to pack, being less springy than freshly cut grass.

The material was laid in the silo in layers 2 to 3 inches deep and well compacted by trampling down, particular care being taken at the sides and corners of the pit to exclude air as much as possible from in between the ensiled material.

In each layer, the butt ends were placed to face one direction, reversing the direction in the next layer. The material was laid down, end to end, but in such a manner that it overlapped for about one-third of its length. With this system of arranging the charge, very close packing was ensured.

After the pit was filled to ground level, a three-foot fence was constructed round the inner dimensions of the silo by driving down stakes in between the material ensiled and the sides of the pit. Care was taken that the stakes were smooth, so that the whole structure could slip down into the silo as the material in the pit started settling.

This improvised cradle, lined on the inner sides with old sacking was also charged with more grass and when the whole structure was full, a cover was provided with old sacking. The excavated earth was now drawn round and over the silo and well rammed down, leaving about one foot of earth above the top of the fence, all the time settling was going on. Once the material had fully settled, the height of the earth layer above ground level was 2 feet. The silo was left to mature for 3 months. In the meantime, cracks that appeared in the earth filling were repaired.

The silo used up 50 cart-loads of cut grass weighing 1,000–1,200 lb. each. An area of about 30 feet by 90 feet of Napier or 45 feet by 90 feet of Guinea grass provided a cart-load. On this basis a silo of the above dimensions would need the harvest of cut grass of 3–3½ acres for each charge.

The silo was charged in 9 days, the cut fodder being carted to the silo. Four women did the filling, 2 working in the pit at either end, laying and trampling, while 2 handed down the material.

Three months after the final charging, the pit was opened. The ensiled material had roughly settled to two-thirds the original height. The silage was sliced out with a sharp catty. It was found more economical to cut a broad slice of less depth, than a narrow slice going down the pit.

After removing the silage for 22 days, a halt was made for 6 days to ascertain how far the silage would be effected. It was found that during this interval of 6 days, moulds had penetrated the silage from the exposed cut surface up to a depth of about 12–14 inches. About 4 inches of this penetration were matted with fungus mycelia followed up further by thin strands. A 2-day interval between cuttings showed 2–3 inches penetration of every light fungal growth. It took another 8 days to empty the silo.

The silage had cured well, the general appearance was that of a pale, greenish-yellow to brown colour. The Guinea grass cut just at flowering stage had cured best and had an acid-sweet alcoholic smell. The tender butt-ends of Napier had cured soft, very compact and looked dark-brown, with an offensive sour odour, but cattle relished it all the same. The quantity of the cured silage was 30 feet by 6 feet by 6 feet= 1,080 cubic feet. A cubic foot of silage weighed 30–40 lb. thus giving on the average an out-turn of 1,080 × 35 lb. = 37,800 lb.

SILAGE FEEDING

The farm animals both cattle and goats ate the silage lustily, preferring this to green fodder, when given in a mixture. As it was thought unwise to feed large quantities, particularly as these animals have had no previous experience on silage feeding, an average of 10 lb. per head per day for cattle were allowed at the start, gradually increasing the quantity to 20 lb. Goats were given roughly 1/5 this quantity. Animals fed on silage showed a marked improvement over the rest, looking healthier, active and showing good colour and suppleness of coat.

COST OF PRODUCTION

	Rs.	c.
A.—Capital expenditure :—		
1 Construction of pit, measuring 30 ft. × 6 ft. × 8 ft.—60 men at 2·50 per day	150	0
2 Erection of shed, 40 ft. × 12 ft. including all materials	200	0
Total ..	350	0

	Rs.	c.
B.—Recurrent expenditure :—		
1 Cutting grass—58 women at 1·50 p. d.	87	0
2 Loading and transporting by carts—38 men at 2·50	95	0
3 Charging the pit—36 women at 1·50 p. d.	54	0
4 Making stick fence, covering with earth, &c.—24 women at 1·50 p. d. ..	36	0
5 Filling up cracks, &c.—4 women at 1·50	6	0
6 Removing earth layer for reaching the silage—18 women at 1·50 ..	27	0
7 Cutting and lifting silage out of the silo—56 women at 1·50 ..	84	0
Total ..	389	0

	Rs.	c.
Cost of production of 37,800 lb. of silage	389	0
Cost of production of 1 lb. of silage	1	04

If the fodder was cut and fed direct, the cost would have been items (1) plus (2) of B, *i.e.*, Rs. 182. Thus the extra cost of converting the fodder into silage has been Rs. 389–Rs. 182.

i.e.—Rs. 207 for 37,800 lb. which is about $\frac{6}{10}$ cts. per lb.

If the material is chopped into lengths of 8–12 inches by means of a power driven chopper, a much larger quantity could be charged into a silo of known size. Such material could be better packed, less earth would be required for weighing down, while the removal of the prepared silage would be considerably easier. With these improvements it would be possible to convert the fodder into silage at a low cost as $\frac{1}{2}$ cts. per lb.

Incorporation with the fodder grass, to the extent of about one-tenth its bulk, spread thinly between layers, of a leguminous fodder crop such as " Stylo ", *Stylosanthes gracilis*, a late introduction to Ceylon from Australia and found to luxuriate in the dry zone, would greatly enchance the feeding value of the silage.

SUMMARY

At the Bata-ata Board and Lodging Station for farm animals, where the need for pasture and fodder grass feeding during the annual drought periods is keenly felt, a system of conserving the green fodder so plentifully found during the monsoon periods, has been successfully evolved.

This has been made possible by preparing silage in a pit silo, which type has been found most suitable, taking into consideration the meteorological aspects of the area. The procedure adopted in silage making and the results obtained are given.

While the animals fed on the prepared silage had shown definite improvement, the drought insurance value of silage as a cattle feed has been amply demonstrated.

The economics of silage making is given, with observations on possible methods of further reducing the cost of silage making, and improving the feeding value of grass silage by the incorporation of a lately introduced leguminous fodder crop.

TECHNICAL MEMORANDUM

TESTING PADDY SEED FOR PURITY BY THE METHOD OF SEQUENTIAL ANALYSIS

IN Departmental Circular No. 152 the standard of genetical purity of pure line paddy which shall be acceptable is fixed at 99 per cent. A bushel of paddy will contain 700,000 to 1,000,000 grains depending on their size and shape. If 800,000 is taken as a mean then an impurity of 1 per cent., would allow 8,000 off-type grains per bushel of 16,000 in an acre sown at the rate of 2 bushels per acre. This is a degree of mixing that I still consider undesirably high, even recognising that in bulk seed purity is only a relative term, but to fix a higher standard now would mean little distribution of improved paddy. If a sample of paddy is properly handled a much higher degree of purity can be achieved than that now laid down, at any rate as far as genetical purity can be determined by characters in the threshed grains. A certain amount of impurity will always escape detection because F, natural hybrids may be present without showing their characters till later, but experience has shown that impurity from this cause is small. If a degree of contamination of one per cent. is permitted then on a bushel content of 800,000 grains there would be 8,000 rogues per bushel or 2·6 per $\frac{1}{4}$ oz. *on average.* If pure seed paddy is to be limited to a maximum amount of mixing of one per cent., it is necessary to consider the methods to be used in testing for purity. There are more problems in testing for genetical purity than often realised, but it is not the purpose of this memo to enter deeply into the statistics involved. Those statistically minded may consult Rhind & Subramaniam Agric. & Livestock in India I (1936), p. 135 and also Sequential Analysis in Inspection and Experimentation by Statistical Research Group, Columbia University. The following are points to note :—

(*a*) If a number of small samples are drawn from a bulk lot and a record made of the numbers of off-type grains in each sample, then when the degree of mixing is high the numbers of off-type will be distributed approximately normally. As the degree of mixing falls the distribution-curve becomes more and more skew until the Poisson distribution is reached.

(*b*) With high contamination there will be one or more off-type grains in every sample, but with low contamination there will be a number of samples carrying no off-type grains. If a sample is drawn and shows no off-types it does not follow that the bulk is free from mixing ; it may, in fact, be very badly mixed. How are we to decide how many samples (and size of samples) which should be drawn from each bulk sample? (Samples must be used because to examine the whole bulk is impossible.)

Use can be made of the statistics of the Poisson distribution curve and the method of Sequential Analysis developed secretly during the war. The main points are these :—

(*a*) It is possible to say how many samples of a given size having a given mean content of off-types will be found to contain 0, 1, 2, 3—*n* off-types

(*b*) The number of samples which should be drawn to ensure acceptance or rejection of a bulk lot according to its estimated degree of mixing is reduced to a minimum.

(*c*) The statistical risks involved can be fixed beforehand.

(*d*) The method is simple though the mathematical theory is complex. The latter, is however, only for specialists. The problem is this—

We desire to know whether or not a bulk sample is mixed to an extent greater than one per cent. and we intend to fix the risks we are prepared to take both in regard to the possible rejection of a lot better than our standard and also worse (*i. e.*, containing over 1 per cent. rogues) than the standard. The two risks need not necessarily be the same. At present there is a dearth of pure seed and the rejection of a lot better than our standard may be thought more serious than acceptance of a lot slightly worse. We will then set the risk of rejection of a "good" sample lower than that for acceptance of a "bad" sample. We can also set the highest limit of contamination we are prepared to accept. The procedure is then—

Fix size of samples.

This will be $\frac{1}{4}$ oz. each. It need not be very accurately wieghed. A small tin measure filled level would do. A $\frac{1}{4}$ oz. sample will contain about 2·6 off-types on an average if 1 per cent. mixture is present.

(2) Fix the risks we are prepared to take of rejecting a good sample or accepting a bad one. These are to be P = 0·01 and P = 0·05 respectively.

(3) Draw up a sampling table (Using various mathematical procedures omitted here) showing acceptance and rejection numbers for a series of samples.

Sampling Table for $\frac{1}{4}$ oz. paddy samples when the maximum mixture is 1 per cent., and P = 0·01 and 0·05 respectively for rejecting a good sample or accepting a bad sample.

No. of Sample examined.	Acceptance Number.	No. of off-types found in each Sample.	Running Total of off-types.	Rejection Number.
1	2	3	4	5
1	—			17
2	—			20
3	0			23
4	3			26
5	5			29
6	8			32
7	11			35
8	14			38
9	17			41
10	20			44

(4) Proceed to draw the first $\frac{1}{4}$ oz. sample. Examine grain by grain and count those which appear off-type. Enter the number in column 3 and the running total in column 4. Continue to draw samples and treat as above until in either.

(*a*) the total number of off-types equals or is *less* than one of the figures in the acceptance column. (*N.B.*—If samples 1 or 2 or both show (zero off-types a third sample is necessary), or

(*b*) equals *or exceeds* one of the numbers in the rejection column.

Example 1.—A series of ¼ oz. samples are drawn, examined and the following figures for off-types obtained :—

Sample No.	Column 3.	Column 4.	
1	2	2	
2	1	3	
3	3	6	At the 8th sample the work stops. The total rogues found in the 8 samples equals the acceptance number (14) and the bulk is passed as up to (or above) standard, with a probability of 1 in 20.
4	0	6	
5	1	7	
6	2	9	
7	4	13	
8	1	14	

N. B.—It is not correct to say that with 14 rogues in 8 samples the average rogue content is 14 or 1·75 per sample. This figure is negatively baised and the true average is higher. The reverse holds for rejection samples.

Example 2.—

Sample No.	Column 3.	Column 4.	
1	3	3	
2	7	10	The 5th sample brings the total rogues to 30 which exceeds the rejection figure of 29 for 5th sample. The bulk is rejected with a risk of only 1 in 100 of a mistake being made.
3	4	14	
4	11	25	
5	5	30	

Rule.

(*a*) When the total in Column 4 equals the rejection number (or exceeds it) the bulk is totally rejected and sampling stops.

(*b*) When the total of column 4 equals the acceptance number or is below it the bulk is passed and sampling stops.

(*c*) When the total of Column 4 lies between the acceptance and rejection numbers a further sample or samples must be drawn until either (*a*) or (*b*) happens.

The advantages of this method are that it is simple, statistically valid and avoids all unnecessary sampling, while giving the degree of certainity which has been fixed as the minimum necessary. The assumption has been made that the number of grains per sample does not vary widely. For some small-grained types this is not true but the only effect in practice is to make the test rather more severe.

For private Seed Farmers Paddy, where the same standard of genetical purity cannot be expected as on departmental farms, it is proposed to fix 97 per cent. as the minimum acceptable. The following table should be used in such cases. The sampling is exactly the same as for paddy of 99 per cent. purity.

Sampling Table for $\frac{1}{4}$ oz. paddy samples when the maximum mixture is 2·5 and P = 0·01 and 0·05 respectively for rejecting a good sample or accepting bad sample.

Sample No. 1	Acceptance Number. 2	No. of off-types in each Sample. 3	Running Total of off-types. 4	Rejection No. 5
1	—			
2	—			40
3	—			48
4	7			55
5	14			62
6	21			69
7	28			76
8	35			83
9	43			91
10	50			98
				105

March 15, 1948.

D. RHIND,
Director of Agriculture.

DEPARTMENTAL CIRCULAR No. 152

HANDLING AND TESTING SEED PADDY

1. This Circular will replace D. C. No 134 which is hereby cancelled.

2. A. OO will be responsible for the purity of seed paddy issued to cultivators and also for testing the germination and purity of seed paddy prior to issue.

3. It is imperative that the utmost care should be exercised in handling pure-line seed paddy to prevent avoidable admixture of even a single grain. The standard of purity of seed paddy on Departmental Stations shall be 99 per cent.

4. Stacking and threshing-floors should be cemented and any cracks that may appear closed. Wherever possible separate stacking and threshing-floors should be set apart for each selection. Where this is not possible a fence should be erected round the threshing-floor and only one entrance provided.

5. Before commencing threshing and/or bagging operations, the threshing machine, winnowing machine, hand winnows, brooms, bushels and other measures, &c., should be thoroughly cleaned and carefully examined for any stray grains of paddy.

6. When buffaloes are employed for threshing, care must be taken to see that their hoofs are clean before admitting them to the threshing-floor.

7. When handling different selections, labourers should be warned to dust their clothes free of any seed adhering to them, before entering the threshing, drying or measuring floors.

8. New gunny bags should be used for storing pure-line seed paddy.

Until a supply of new bags is secured, second-hand bags supplied should be thoroughly cleaned both inside and outside, before being brought to the threshing and measuring floors.

9. Dogs, other pets or fowls should not be permitted anywhere near the threshing or drying floors, before seed paddy is bagged.

10. Every bag should be labelled both inside and outside.

11. Bags of seed paddy should be stacked in double tiers to facilitate sampling.

12. One and half months before seed paddy is required for issue, stocks should be examined and if necessary sun dried and re-winnowed.

13. A month before issue, seed should be tested for germination and results recorded in a Germination Register.

14. Germination tests should be carried out by the laboratory method, to determine the percentage of germination, but where no apparatus is available the village method may be adopted.

15. The following instructions will be followed, when drawing samples of paddy for testing :—

(*a*) *When paddy is in gunny bags*—

(i.) When there are less than five bags, a sample of about two ounces should be taken from each bag, the samples thoroughly mixed and used for testing.

(ii.) Where there are more than five bags, but less than twenty-five bags samples of about two ounces each, should be drawn at random from every two bags in five bags. The portions should be mixed as above and used for testing.

(iii.) Where there are more than twenty-five bags, the bags should be arranged in groups of twenty-five each and each group labelled.

From each group samples should be drawn as at (ii.) above. If space does not permit the arrangement of bags in groups, each bag should be marked to distinguish the group to which it belongs.

(*b*) *When paddy is in heaps, bins or bisses* :—

Approximately quarter pound samples should be drawn from various parts of the heaps or bins, the samples thoroughly mixed and used for testing.

16. Seed paddy in storage should be tested for germination every two months and if found unsuitable for issue, should be at once disposed of for consumption.

17. The minimum germiation percentage should be 85 per cent.

18. Seeds of *Echinocloa* Spp. must be entirely excluded.

19. Admixture of chaff, earth, stones, leaves, weed-seeds and other rubbish should not exceed five per cent. by weight. Samples for testing purity should be drawn in the same way as for germination tests (para. 15), immediately after winnowing and should be repeated if found necessary.

20. Genetical purity shall be tested soon after winnowing by the method of Sequential Analysis, details of which are given in a separate memorandum. Lots failing to pass this test at 99 per cent. genetical purity should not be issued unless no better paddy is available.

If seed paddy below standard has to be issued prior sanction of the Director must be obtained.

It is imperative that purity must be raised to this standard by March, 1950, after which, any farm growing paddy found to be below standard will be subject to severe disciplinary action.

21. Certificates of germination and purity should only be issued when specially called for, but no seed paddy should ever be issued without previous tests and a record of every test must be maintained on the farm from which the paddy is issued.

Under no circumstances should bad seed paddy be issued.

22. Certificates of germination and purity shall not be issued to private seed farmers unless specially called for, but a record of each issue shall be made in such a way that the purity and germination of paddy could be traced.

23. A. OO must satisfy themselves that the private seed farmers' stocks are suitable, for issue and the purity standard must be raised till it is 97 per cent. genetically pure by 1951.

24. Normally seed paddy could be issued up to eight months from the date of harvest; even if germination is satisfactory, paddies stored for ten months from date of harvest may not be issued.

D. Rhind,
Director of Agriculture.

Peradeniya, April 15, 1948.

AMENDED DEPARTMENTAL CIRCULAR No. 156

PURE-LINE PADDIES MAINTENANCE OF PURITY

1. This Circular will replace D. C. No. 144 of 30.6.47.

2. The maintenance of purity of pure-line selections of paddy will be the responsibility of the Agricultural Research Officers.

3. The technique employed will be as follows :—

(*a*) To bag at emergence four plants typical of the selection in the progeny rows.

(*b*) Grain sizes are one of the most constant characters and should be recorded for every pure-line under distribution.

(*c*) To grow the seed of each of these plants in three progeny rows. If any of the progeny rows show evidence of segregation all three rows belonging to the same bagged plant shall be totally discarded. Progeny rows must be transplanted at a spacing of two feet between rows and one foot between plants in the rows.

(*d*) To examine in the field each individual plant in the progeny rows, discard the outside rows and bulk the seeds of the centre row.

(*e*) To transplant $\frac{1}{4}$ acre with bulk seed from plot (*d*).

4. The A. R. OO will issue small quantities of pure seed from the produce of plot (*e*) to major paddy farms, and the A. O. in-charge will carry the multiplication further until they can fully sock their farms. When this stage has been reached seed will be issued to Minor Farms, Private Seed Farms and Cultivators. The A. O. must obtain fresh nucleus seed each season from the A. R. O.

5. To summarise, the procedure will be as follows :—

The A. R. OO will multiply up to $\frac{1}{4}$ acre each pure-line allotted to them. Seed from this $\frac{1}{4}$ acre will be sent, each season, to selected large farms where the A. OO will be responsible for further multiplication and distribution.

6. It is proposed to publish in the Departmental information page of the " The Tropical Agriculturist ", the botanical characters of all the departmental pure-line selections.

The botanical characters should be used by all officers for checking up the purity of their paddies. Any variations observed should be reported at once.

7. In the accompanying table are given particulars of all departmental pure-lines, the Station at which purity will be maintained, the A. O. who will be responsible for further multiplication and distribution.

D. RHIND,
Director of Agriculture.

Peradeniya, April 15, 1948.

PURE-LINE PADDIES

MAINTENANCE OF PURITY

	Name of Paddy.	Age.	Season grown Maha Yala.	Station at which purity will be maintained.	D. A. O. to receive first issue of Seed.
1.	Podiwi A 3 ..	6 months ..	M ..	Madampe ..	A. O., N.-W. D.
2.	Molagusamba I 18 6	do. ..	M ..	do. ..	do.
3.	Kohumawi B 11 6	do. ..	M ..	Maha-Illuppallama ..	A. O., C. D.
4.	Kurulutuduwi B 13	do. ..	M ..	do. ..	do.
5.	Dewereddei 26031.	5–5½ months	Y ..	Bathalagoda ..	A. O., S.-W. D.
6.	Vellai Illankalayan 28061 ..	4 months ..	M ..	Maha-Illuppallama ..	A. O., N.-C. D.
7.	Balamawi 31009 ..	do. ..	M ..	Ambalantota ..	A. O., S.-E. D. (Mapalana)
8.	Perillanel 26014 ..	do. ..	M ..	Maha-Illuppallama ..	A. O., E. D.
9.	Oddavalan 2449/20	do. ..	M ..	do. ..	A. O., N. D. (Vavuniya)
10.	Hondarawala 868..	do. ..	M ..	do. ..	A. O., S.-W. D.
11.	Madael 39 MY 137	3½–4 months.	Y ..	Ambalantota ..	do.
12.	Suduheenati 1 1 CPYN 19 ..	do. ..	YM ..	do. ..	A. O., S.-E. D.
13.	Suduheenati Hf 9..	3½–3¾ months	YM ..	do. ..	do.
14.	Sinnanayan 38 Y 2203	3½ months ..	YM ..	do. ..	do.
15.	Rath Karayal 38 YM 3753 ..	do. ..	YM ..	do. ..	do.
16.	Kaluheenati 39 YM 3254 ..	do. ..	YM ..	Bathalagoda ..	A. O., S.-C. D.
17.	Sulai 27614 ..	do. ..	MY ..	Ambalantota ..	A. O., S.-W. D.
18.	Pachchaiperumal 2452 11 ..	3 months ..	Y ..	Maha-Illuppallama ..	A. O., N-C. D.
19.	Dahanala 37 YM 2014 ..	do. ..	YM ..	Ambalantota ..	A. O., S.-E. D.
20.	Murunga 39 YM 137	do. ..	YM ..	do. ..	do.
21.	Vellai Perumal 28724 ..	do. ..	Y ..	Maha-Illuppallama ..	A. O., E. D.

MYCOLOGICAL

THE 1947 season in the low country showed on the whole a rather mild attack of *Oidium*, though late wintering trees suffered at least one complete defoliation. The wintering season was delayed, owing to the heavy rainfall of the previous November and December, and the first signs of wintering on Dartonfield occurred in the first week of January, whereas the present wintering season has begun in early December. By the end of January, 1947, the first trees had commenced refoliation and on the 7th February, a few colonies of *Oidium* were found scattered at random over their leaves which had then reached the full green stage and were practically of mature size ; the colonies were confined to the upper surfaces of the few leaves infected and in most instances only a single colony was present on a leaf. These leaves did not shed, but the *Oidium* remained on them producing abundant conidia for 3–4 weeks. During the remainder of February the fungus gradually became more prevalent, though mostly confined to leaves in the green stage of semi-maturity and hence very little leaf shedding occurred. About 1st March, the habit of the fungus suddenly changed and wholesale infection of bronze leaves occurred during the following week, with consequent severe leaf shedding during the next few days. These conditions continued for the remainder of March, after which the epidemic gradually died down except on the extremely late wintering clone PB. 6/9.

Fortunately during the 1947 refoliation season the bulk of the trees on most estates had passed the susceptible stage before the period of severe infection occurred, and hence the epidemic as a whole was less severe than on many occasions in the past.

The story of the 1947–48 wintering period cannot yet be written, but conditions are now almost the exact opposite of those prevailing last year. Instead of a record rainfall in November–December, we have experienced virtually a record drought, with the result that wintering of the rubber trees has been advanced about six weeks for most clones. Yet the story so far of the annual *Oidium* attack has been identical with that of last season. The very first tree to refoliate has shown a few scattered colonies (six in all) on its fully expanded green leaves, limited to their upper surface : these were discovered on December 16 and confirmed on December 18th. No trace could then be found on neighbouring trees with somewhat younger leaves but until the end of the month there was a gradual spread of the fungus on to them, limited almost entirely to the upper surface of the leaves.

Thus in the low country of Ceylon the *Oidium* epidemic commences each year as a few colonies on the very early wintering trees and spreads from them for about a month to the fairly mature green leaves of their successors to winter. Eventually the foliage of the latter becomes quite heavily attacked, but being past the extremely susceptible bronze stage it does not shed in any serious amount. Then for some reason still entirely unknown the fungus suddenly makes a large scale attack on younger bronze leaves, develops very rapidly on them and causes wholesale shedding within 5–6 days after infection. Some years this severe attack may be repeated once or twice before the epidemic gradually dies down and the trees are able to form a permanent foliage for the year. In other years most trees suffer none or only a single defoliation. From this general picture of the *Oidium* epidemic in the Ceylon low-country arise a number of questions, and attempts have been made during 1947 to provide answers to some of them.

The first question is that of the persistence of *Oidium* in the low country throughout the year. At Dartonfield there is a small area of a very late-wintering clone PB. 6/9, and in 1947, it suffered defoliation from *Oidium* repeatedly until mid-May, and it was not until towards the end of June that it was able to form a reasonably dense canopy. Even then some of its leaves bore active *Oidium* colonies up to early August. Unfortunately this year a severe epidemic of *Phytophthora* occurred in July–August so that normal conditions of foliage renewal were considerably upset. In September, after the leaf fall caused by this fungus there was abnormal amount of young foliage present on the trees, and it was expected that *Oidium* would attack it. Close examination of many trees failed to reveal any sign of its presence, however, although a few colonies of *Oidium* had been found towards the end of July on a tree artificially defoliated on July 1st. This absence of *Oidium* on young foliage in September was very unexpected, especially as on October 1st, two colonies were found on a 2-year old seedling tree growing in a water-course reservation at Dartonfield. It is still possible that occasional colonies may have occurred on the September crop of new foliage, and were missed by the field glass examinations made. The Mycologist's opinion is that this possibility of very small scale existence cannot be entirely ruled out, and would account for the few colonies appearing on the very wintering trees each season.

The second point arising from the field study of the annual *Oidium* epidemic is the origin of the original colonies found each season. The old explanation was that the fungus was able to exist in some resting form in the buds of the trees, as is known to happen in the case of some nearly related mildews of temperate plants. Mere examination of the occurrence of the original colonies of the rubber mildew shows that there is no definite relation to buds. The colonies are few in number, and may occur on single leaflets of the comparatively large number formed from one dormant bud ; they are most often situated in the centre of the upper surface and never occur on the lower surface ; and finally bear no relation to the stem of the twig on which they occur. It is concluded that they result from sporadic air-borne conidia of the fungus. This conclusion was tested by enclosing dormant branches in cellophane bags, and allowing the buds to develop their foliage within the bags while protected from outside infection. Great trouble was found in rendering these cellophane bags capable of standing up to heavy rainstorms, but the trials were successful enough to indicate that no *Oidium* develops under such conditions. Even in the case of bags damaged, such infection as did occur was always on leaves exposed to the outer air through openings in the bags. It is possible however that the conditions of absolute saturation of moisture inside the bags would prevent development of *Oidium*, and this alternative explanation of the experimental results needs testing further. All that can now be said is that evidence hitherto indicates that the fungus is air-borne to the leaves of the trees first to winter in each season, and that having once infested these, the origin of the epidemic is thereby accounted for.

With regard to clonal resistance and susceptibility, we have as yet no evidence of any sufficiently high degree of resistance to be of commercial value amongst any clones at present in existence in Ceylon. One of the more promising kinds of resistance was shown in 1947 by HC. 28—a late wintering clone which becomes quite heavily infected with *Oidium* but shows comparatively little leaf shedding. Further observations are needed on this matter, especially in view of the marked differences in behaviour shown by any individual clone when planted in different situations. This variability in reaction to *Oidium* also extends to the relative date of wintering of any clone in comparison with others close by, and is also shown from season to season. For instance in the 1946–47 season the first trees to winter and to refoliate at Dartonfield were those of RRI. 506, and the first signs, of *Oidium* were found on one tree of this clone. In the 1947–48 season some trees of PB. 183 which had not recovered at all well from the *Phytophthora* leaf fall in August–September, were first to winter, and one tree of this clone showed the first colonies of *Oidium* this season.

The conditions governing the sudden increase in severity of *Oidium* attack on young bronze leaves each year remain entirely undiscovered. Much time has been spent by the Mycologist in detail examination of meteorological records dating back to 1935, and no correlation has yet been discovered to indicate that one or two meteorological factors control such development. Our present knowledge renders it impossible to give more than 4 or 5 days warning of an impending epidemic, and such a warning would be of use inly on the individual estate under very detailed day to day observation. Hence it is not yet possible to give estates in general any useful forecast of when to commence dusting operations or whether these can be dispensed with in any given season. If it became possible even to give 14 days notice of danger of heavy attack than in years of light attack estates might be saved this expense. Present prospects are that such a long-term forecast will not become possible for some years to come.

The condition and yield figure of neighbouring estates may be taken as reflecting a general summary of conditions over the past 10 years, and in this matter a comparison between Dartonfield, dusted regularly each year, and Mukalana, never dusted, shows that *Oidium* in this district has not been severe in its effects.

Conditions relating to *Oidium* on estates in the drier and more elevated disticts of Matale and Kandy are altogether different from those in the low-country. The fungus exists in quantity throughout the year there on all trees having foliage in a susceptible condition. In these districts it is virtually impossible to obtain a reasonable density of foliage without the most careful and regular sulphur dusting possible.

Before leaving the subject of the epidemiology of *Oidium* it is necessary to correct a istatement often repeated in the past, that the fungus is capable of infecting mature rubber leaves. No single case of such infection has been observed by the Mycologist, and all spots and deformations shown by mature rubber leaves as due to *Oidium* attack are merely the long-term results of infections occurring at the latest about 3 weeks after the buds open. After infection has once occurred the fungus is able to exist on the leaf in active and sporulating condition for 6–8 weeks at the most, when its mycelium gradually disintegrates and dies away. The only reasonably efficient control measure for a disease of this nature, affecting a comparatively large tree is that of sulphur dusting both to protect young foliage against infection and to control to some extent the development and sporulation of colonies already formed. There is some indication that present apparatus and sulphur dusts are not ideal, but with the limited facilities available to the Rubber Research Scheme it is not possible to make detailed investigations of these matters. Fortunately Imperial Chemical Industries have recently taken an interest and have promised to make trials of new dusts and machines in England, before sending them to us for field tests. From their resources we may hope to obtain results of practical value to rubber planters in a much shorter time than would otherwise be possible.

The essential of control of *Oidium* in a district liable to severe and regular annual attack is very careful supervision and frequent repetition of small doses. Unfortunately the districts concerned are those in which the crop is least profitable, and hence the recent Rubber Commission has recommended that rubber is no longer a practicable crop there.

The rubber estates of the low-coun ry districts of Ceylon suffered an exceptionally severe epidemic of *Phytophthora* leaf fall in August–September 1947, probably the worst outbreak for about twenty years. Reports in inspections showed that no individual clone possessed everywhere any marked resistance to the attack, though a few clones such BD. 5 proved particularly susceptible on almost all estates. The other standard clones such as TJ. 1 and PB. 86 on most estates showed moderate attack, but somewhere or other each clone suffered severely. Following the actual leaf fall due to the attack, outbreaks of various forms of bark rot and canker on branches and main stems occurred, though in the case of these forms of *Phytophthora* attack

the standard clones TJ. 1, PB. 86, HC. 28 and GL. 1 did not suffer to the same extent as some others including BD. 5 and PB. 153. All low-country estates were advised of the dangers consequent upon this severe attack of *Phytophthora*, and special precautions must be continued at least until the end of 1948 to ensure that all canker and bark rot patches are thoroughly cleaned up and healed. With the present economic situation of the Ceylon rubber industry, it is manifestly completely impossible to attempt to prevent *Phytophthora* leaf fall, but it is important to clean up annually all patches of stem and branch attack of this fungus.

The question of root disease, almost entirely due to *Fomes lignosus*, in replanted areas is coming very much to the fore in view of the heavy replanting programmes now under way. There appears to be much more danger of damage from this disease in replanted areas than in rubber planted on virgin land, probably due entirely to the presence of susceptible roots of the old rubber in the soil. Present experience leads to the view that in many fields of old rubber in Ceylon there exist frequent incipient or quiescent foci of *Fomes* root disease, though the old trees do not show any symptoms. When the rubber is felled and replanted, the first sign of the presence of *Fomes* is the death of a proportion of the young plants, usually about 9–12 months after planting. Their roots show the typical mycelial strands of the fungus, which cannot be mistaken. Although it may not prove possible completely to prevent such attack in young replanted fields, there are a few precautions which can be adopted to minimise the danger. At the time of felling and the old rubber, the main roots exposed by felling should be examined immediately for signs of *Fomes*: a few hours delay may obscure all signs. Infected or doubtful trees should be marked and later their root system further exposed for detailed examination. Where the fungus is found, all infected roots should be carefully dug up and burnt, as completely as possible, before replanting is commenced. Where the old stand has been poisoned with arsenite this precaution is not possible. The bases of the old trees after felling are best left *in situ*, as we have found at Dartonfield that they form useful indicators of *Fomes*. If they have been attacked by this fungus, its fructifications soon appear on the rotting wood, instead of the normal crop of other harmless wood rotting fungi, and then all roots belonging to the infected stump and its immediate neighbours of the old stand should be opened up and infected material burnt. If the *Fomes* patches are not so treated immediately they are noticed, there is danger that the mycelium may spread rather extensively along the dying root systems of the old stand, and hence infect a much larger area than would otherwise be the case. The disease is capable of causing considerable damage in young replanted fields, especially now that our modern fields contain a much closer stand of plants, and it should prove well worthwhile to take steps to control it at the earliest possible stage, before the infection has become widespread and expensive to treat properly.

[Extract from the Report of the Director of Rubber Research, 1947, pages 3–7.]

RUBBER RESEARCH SCHEME (CEYLON)

MINUTES OF THE EIGHTY-SEVENTH MEETING OF THE RUBBER RESEARCH BOARD HELD AT THE PLANTERS' ASSOCIATION BUILDING, COLOMBO, AT 2.30 P.M. ON MONDAY, APRIL 26, 1948

Present.—Mr. D. Bliss, Director of Agriculture in the Chair, Mr. H. E. Peries, C.C.S., Deputy Secretary to the Treasury, Mr. Simon Abeywickrema, M.P., Mr. C. A. C. Bowen, Mr. W. P. H. Dias, J.P., Mr. T. C. A. de Soyse, Mr. E. Jayewickrema, Mr. F. A. Obeyesekere and Mr. E. J. O. Richardson.

Dr. E. Rhodes, Director, was present by invitation.

Apologies for absence were received from Messrs. P. H. Griffith, M.P., R. J. Hartley and A. D. Layton.

1. MINUTES

(a) *Minutes of last meeting.*—Draft minutes of the meeting held on December 15, 1947, which had been circulated to members, were signed as signification of members' assent that they were in order.

(b) *Report of Finance Committee.*—Reported that the report had been presented to the Minister for Agriculture and Lands and that a deputation consisting of the Chairman, the Director and five members of the Board had waited on the Minister.

2. DECISIONS BY CIRCULATION OF PAPERS

Sale of an investment.—Reported that members had agreed to the sale of Rs. 100,000 stock of Ceylon Government 3½ per cent. Loan 1942/51.

3. BOARD

(a) *Mr. L. J. Senevirame.*—A letter of thanks from Mr. L. J. Senevirame, late Chairman, was read.

(b) *Membership.*—The following changes in membership were reported :—

(1) Mr. H. E. Peries, C.C.S., Acting Deputy Secretary to the Treasury, had been nominated to represent the Minister of Finance in place of Mr. T. B. Perera during the latter's absence from Ceylon, with effect from March 20, 1948.

(2) Mr. E. J. O. Richardson had been nominated to represent the C.E.P.A., with effect from January 1, 1948, in place of Col. J. T. Young who had resigned.

(3) Mr. Errol A. Jayewickrema had been nominated as a representative of the L.C.P.A., with effect from February 25, 1948, in place of Mr. W. Neal de Alwis whose period of membership had expired.

(4) Mr. A. D. Layton had been nominated by the P.A. of Ceylon, to act for Mr. R. C. L. Notley during the latter's absence from Ceylon, with effect from April 16, 1948.

The new members were welcomed to the Board and the retiring members thanked for their services.

4. EXPERIMENTAL COMMITTEE

(a) *Membership.*—Agreed that Mr. E. Jayewickrema should serve on the Committee in place of Mr. R. C. L. Notley during the latter's absence from Ceylon.

(*b*) *Recommendations made at meeting held on April 12, 1948 :—*

(1) *Ceylon Estates Employers' Federation.*—The recommendation that membership of the Ceylon Estates Employers' Federation be sought was approved.

(2) *Visiting Engineer's Report—*

Water pumps.—The recommendation that two new pumps be purchased to replace existing ones was approved.

(3) *New National engine and generator.*—A supplementary vote of Rs. 12,716 was passed to cover the increased cost of the new engine and generator.

(4) *Multiplication of special Prang Besar clones.*—Agreed that the temporary arrangement for multiplication of certain promising P.B. clones should not be continued but the local agents of the Prang Besar Co. should be given time to establish the material in their own nurseries.

(5) *Charges for supply of electric current to bungalows.*—A new scale of charges for electricity supplied to bungalows, based on the salaries of the occupants, was approved.

(6) *Hedigalla cart road.*—As recommended by the Committee, a vote of Rs. 8,000 was passed for construction of the 5th half mile of road and it was also agreed that the next half mile be constructed on estate account.

The minutes were then adopted.

5. REPORTS AND ACCOUNTS

(*a*) *Annual Report for 1947.*—Members complimented the Director on the report which showed that good work had been done which would be of benefit to the industry particularly in regard to *Oidium* leaf disease. The report was adopted.

(*b*) *Director's report for the 4th quarter, 1947.*—was adopted.

(*c*) *Statements of Receipts and Payments for the 3rd and 4th quarters, 1947.*—were approved.

(*d*) *Estate accounts July to December, 1947.*—were tabled.

(*e*) *Re-vote of 1946 capital votes.*—Balances of 1946 capital votes amounting to Rs. 86,032 were re-voted.

(*f*) *Travelling expenses on taking up first appointment.*—Agreed that officers' travelling expenses on taking up first appointment should be paid in accordance with the terms of the relative Financial Regulations.

6. STAFF

(*a*) *Mr. T. E. H. O'Brien (late Director).*—Agreed that the Minister be again approached for his consent for amendment of the Ordinance to enable the payment to Mr. O'Brien of a pension as approved earlier.

(*b*) *Chemist.*—A letter from Mr. M. W. Philpott thanking the Board for the references made regarding his work during his period of service with the Scheme was read.

(*c*) *Mycologist.*—The departure of Mr. C. G. Hansford, Mycologist, on January 14, was reported.

Mr. de Soysa and Mr. Richardson left the meeting.

(*d*) *Botanist.*—Reported that Mr. C. A. de Silva, Botanist, had accepted re-engagement for a further period of 4 years and 3 months.

Consideration of the other items on the agenda was postponed.

Dartonfield,
Agalawatta, May 11, 1948.

C. D. DE FONSEKA,
Secretary-Accountant.

RUBBER RESEARCH SCHEME (CEYLON)

MINUTES OF THE EIGHTY-EIGHTH MEETING OF THE RUBBER RESEARCH BOARD, HELD AT THE PLANTERS' ASSOCIATION BUILDING, COLOMBO, AT 2.30 P.M. ON MONDAY, MAY 31, 1948

Present.—Mr. W. P. H. Dias, J.P. (in the Chair), Mr. C. A. C. Bowen, Mr. Noel de Silva, Mr. E. R. de Silva, Mr. R. J. Hartley, Mr. Errol A. Jayawickreme, Mr. A. D. Layton and Mr. E. J. O. Richardson.

Dr. E. Rhodes, Director, was present by invitation.

An apology for absence was received from Mr. F. H. Griffith, M.P.

It was reported that Mr. D. Rhind, Chairman, was unable to attend the meeting owing to illness. Mr. Hartley then proposed and Mr. Bowen seconded that Mr. W. P. H. Dias should take the chair. Agreed.

1. MINUTES

Draft minutes of the meeting held on April 26, 1948, which had been circulated to members, were signed by the Chairman subject to amendment of item 4(*a*) to read as follows :—

> Mr. Jayawickrema proposed and Mr. Abeywickrema seconded that Mr. T. C. A. de Soysa should act for Mr. R. C. L. Notley on the Experimental Committee during the latter's absence from Ceylon.

2. BOARD

(*a*) *The late Mr. Simon Abeywickrema, M.P.*—The Chairman referred to the death of Mr. Simon Abeywickrema who had been a useful and active member of the Board since March, 1946. A vote of condolence was passed in the usual manner.

(*b*) The following changes in membership were reported :—

(1) Mr. R. Bois had been nominated by the Agency Section of the Planters' Association of Ceylon to act for Mr. W. H. Attfield during the latter's absence from Ceylon, with effect from May 28, 1948.

(2) Mr. E. R. de Silva had been nominated as a representative of the Low Country Products Association of Ceylon with effect from May 21, 1948, in place of Mr. A. M. Clement Dias whose period of membership had terminated.

(3) Mr. W. P. H. Dias, J.P., had been re-nominated as a representative of smallholders for a further period of three years from June 10, 1948.

The new members were welcomed to the Board and the retiring members were thanked for their services.

3. STAFF

Changes in junior staff were reported.

4. **VULCANISING EQUIPMENT**

Agreed that certain items of vulcanising and testing equipment which are now not required by the Scheme be sold to the Department of Industries and the Rubber Research institute of Malaya.

5. **MEDICAL FUND**

Alteration of Rule No. 12 of the Junior Staff Medical Fund to provide for the case of officers promoted to the senior staff was approved.

6. **PUBLICATIONS**

The following publications were tabled :—

Annual Report for 1946.
Combined 3rd and 4th Quarterly Circulars for 1947.

Referring to the Quarterly Circular, Mr. Hartley congratulated the Director on the production of a first class publication which contained valuable information on re-planting, &c., in non-technical language.

7. **LONDON ADVISORY COMMITTEE FOR RUBBER RESEARCH (CEYLON AND MALAYA,**

Minutes of meetings of the Committee and the Technical Sub-Committee held on November 7, 1947, and March 5, 1948, were tabled.

8. **GRADUATE RESEARCH ASSISTANTS**

Agreed that the salary scale of Graduate Research Assistants be brought into line with the Government scale.

9. **MEETINGS**

Agreed that one meeting per year be held at Dartonfield.
The meeting terminated with a vote of thanks to the Chair.

Dartonfield,
Agalawatta, June 7, 1948.

C. D. DE FONSEKA,
Secretary-Accountant.

COCONUT RESEARCH SCHEME (CEYLON)

BOARD OF MANAGEMENT

DRAFT MINUTES OF THE NINETY-THIRD MEETING OF THE BOARD OF MANAGEMENT, COCONUT RESEARCH SCHEME, HELD AT 10 A.M. ON SATURDAY, MAY 8, 1948, AT BANDIRIPPUWA ESTATE, LUNUWILA

Present.—D. Rhind, Esq. (Director of Agriculture) ; Chairman, H. W. Amarasuriya, Esq. (Chairman, L. C. P. A.) ; Vernon Rajapakse, Esq. (Representing the L. C. P. A.) ; C. E. L. de Silva, Esq. (Representing the L. C. P. A.); E. Muttukumaru, Esq. (Representing the P. A. of Ceylon) ; A. Pearson, Esq. (Representing the P. A. of Ceylon) ; D. D. Karunaratne, Esq., J.P., M.P. (Representing the small-holders) ; Graham Panditteseker a, J.P., U.M. (Representing the small-holders) ; Albert F. Peries, Esq., J.P., U.M. (Representing the House of Parliament) ; N. H. Keertheratne, Esq., M.P. (Representing the House of Parliament) ; Dr. Reginald Child (Director) ; Mr. S. C. Kahawita (Secretary).

Apology for absence was received from the Acting Deputy Secretary to the Treasury—Mr. H. E. Peries.

1. MINUTES

The minutes of the previous meeting held on February 21, 1948, which had been circulated were confirmed without amendment.

2. CORRESPONDENCE

The Chairman tabled a letter from the Private Secretary to the Minister of Agriculture and Lands which stated that the Prime Minister was unable to attend but that the Minister of Agriculture would be pleased to inaugurate the Field Day. June 26, had been fixed provisionally as the date.

3. BOARD OF MANAGEMENT

(*a*) The Chairman, welcomed Mr. H. W. Amarasuriya, new Chairman of the Low Country Products Association as a member of the Board. In doing so, paid a tribute to Senator C. A. M. de Silva, the previous Chairman of the Low Country Products Association, who had been a member of the Board since November 1, 1941, and has represented various interests of the Coconut Industry. Mr. A. Pearson and Mr. G. Panditteseker a wished to be associated with the remarks of the Chairman.

(*b*) Mr. H. W. Amarasuriya was elected a member of the Sub-Committee to report on the future development of the Industrial side of the Scheme's Research Policy.

4. STAFF

New appointments.—(i.) Mr. J. K. F. Kirthesinghe who was appointed Field Assistant to Botanist, took up duties on March 15, 1948, and Mr. H. J. F. Peiris, Mr. H. L. L. Perera and Mr. P. B. Perera, who were selected as Temporary Field Advisory Officers took up duties on April 5, 1948.

5——J. N. A 82344 (9/48)

The Board ratified the above appointments. It was decided that when Field Advisory Officers were next recruited, at least one should possess a working knowledge of Tamil.

(ii.) As suggested by the Director, the Board approved that one of the temporary Field Advisory Officers should be attached to the Agricultural Officer, Propaganda, for a period of training in propaganda methods.

5. ESTATES

The Visiting Agent's report on his visits dated March 5/6, 1948, which had been circulated were referred to the Estates Sub-Committee.

6. THE COCONUT REPLANTING SCHEME

Which was drawn up by the Chairman, as Director of Agriculture in consultation with the Director, Coconut Research Scheme and approved by the Hon. Minister for Agriculture and Lands had been circulated to the Board. After discussion the Board decided to record the following resolution.

> "The Board considered the Scheme for provision of more planting material by the Coconut Research Scheme submitted by the Director of Agriculture to the Secretary to the Minister of Agriculture and Lands and is of opinion that the Scheme is generally acceptable to the Board but that additional nurseries are necessary to induce extensive replanting and rehabilitation of existing plantations. The Board considers that some financial inducement, such as taxation relief, is very desirable. The Board also considers that the scale of salary of Rs. 300—10 of 20—500 a month proposed for the Coconut Replanting Officer is too low and recommends a scale of Rs. 6,000—12 of 450—1 of 120—11,520 a year."

7. ANY OTHER BUSINESS

(*a*) It was brought to the notice of the Board by some members who happened to be members of the Coconut Board that the Hon. Minister for Commerce and Trade has in view the setting up of the Coconut Board as a commission under the Coconut Board Ordinance to investigate the Coconut Industry in all its branches including the agricultural and research aspects. In view of this the Board requested the Chairman as Director of Agriculture, to discuss the matter with the Minister of Agriculture and Lands.

(*b*) The date of next meeting was fixed for July 17, 1948, at 10 A.M. in Colombo.

The meeting terminated at 12·30 P.M., with a vote of thanks to the Chair.

By Order,

S. C. KAHAWITA,

Secretary, Coconut Research Scheme.

Lunuwila, June 2, 1948.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED APRIL 30, 1948

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948 to April 30, 1948			
				Deaths	Recoveries	Balance ill	No. shot
Western Province	Foot-and-mouth	—	8	—	8	—	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	23	301	—	300	1	—
	Rabies	5	31	—	—	—	31
Cattle Quarantine Station, Colombo	Anthrax	—	7	7	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	1	—	—	—	1
	Foot-and-mouth	2	2	1	1	—	—
North-Central Province	Foot-and-mouth	304	558	10	413	135	—
North-Western Province	Mange in goats	—	16	—	16	—	—
Sabaragamuwa Province	Foot-and-mouth	460	460	—	325	135	—
Southern Province	Foot-and-mouth	24	760	24	736	—	—
Central Province	Rabies	—	2	—	—	—	2
	Piroplasmosis	—	1	—	1	—	—
Uva Province	Rabies	1	2	1	—	—	1
	Foot-and-mouth	12	36	—	23	13	—

Peradeniya, May 31, 1948.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED MAY 31, 1948

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948 to April 30, 1948			
				Deaths	Recoveries	Balance ill	No. shot
Western Province	Foot-and-mouth	—	8	—	8	—	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and mouth	6	307	—	305	2	—
	Rabies	1	32	—	—	—	32
Cattle Quarantine Station	Anthrax	—	7	7	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	1	—	—	—	1
	Foot-and mouth	—	2	1	1	—	—
North-Central Province	Foot-and mouth	9	567	10	553	4	—
North-Western Province	Mange in goats	—	16	—	16	—	—
Sabaragamuwa Province	Foot-and-mouth	—	460	—	460	—	—
Southern Province	Foot-and-mouth	—	760	24	736	—	—
Central Province	Foot-and-mouth	—	—	—	—	—	—
	Rabies	1	3	—	—	—	3
	Piroplasmosis	—	1	—	1	—	—
Uva Province	Rabies	—	2	1	—	—	1
	Foot-and-mouth	5	41	—	41	—	—

Peradeniya, June 30, 1948.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED JUNE 30, 1948.

Province	Disease	Fresh cases during the month	Cases up to date since Jan. 1, 1948	From Jan. 1, 1948 to June 30, 1948			
				Deaths	Recoveries	Balance ill	No. shot
Western Province	Foot-and-mouth	—	8	—	8	—	—
	Rabies	—	1	1	—	—	—
Colombo Municipality	Foot-and-mouth	—	307	—	307	—	—
	Rabies	3	35	—	—	—	35
Cattle Quarantine Station	Anthrax	—	7	7	—	—	—
Northern Province	Black Quarter	—	9	9	—	—	—
	Rabies	—	1	—	—	—	1
	Foot-and-mouth	—	2	1	1	—	—
North-Central Province	Foot-and-mouth	—	567	10	557	—	—
North-Western Province	Mange (goats)	—	16	—	16	—	—
Sabaragamuwa Province	Foot-and-mouth	—	460	—	460	—	—
Southern Province	Foot-and-mouth	—	760	24	736	—	—
	Rabies	3	3	3	—	—	—
Central Province	Rabies	—	3	—	—	—	3
	Piroplasmosis	—	1	—	1	—	—
Uva Province	Foot-and-mouth	64	105	—	70	35	—
	Rabies	—	2	1	—	—	1

Peradeniya, August 2, 1948.

T. M. Z. MAHAMOOTH,
Deputy Director (Animal Husbandry),
and Government Veterinary Surgeon.

METEOROLOGICAL REPORT, APRIL, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	88·3	—0·7	72·6	—0·9	78	98	6·9	13·55	21	+ 0·16
Anuradhapura	95·9	+4·6	74·3	—0·3	66	90	5·4	2·57	14	— 3·86
Badulla	84·2	+0·1	66·0	—0·2	80	97	5·2	6·48	19	— 0·52
Batticaloa	87·4	—0·4	76·4	—0·3	78	91	5·8	0·95	4	— 1·35
Colombo	87·8	—0·1	75·4	—0·6	80	93	6·6	11·39	20	+ 2·32
Diyatalawa	77·2	—0·6	60·5	0·0	80	94	4·9	6·11	17	— 0·43
Galle	86·1	—0·1	76·1	—0·7	85	91	5·3	16·52	19	+ 7·81
Hakgala	72·9	—1·0	55·4	+0·1	80	91	5·0	8·19	15	+ 1·21
Hambantota	87·3	—0·5	76·4	+0·1	82	91	7·5	9·48	13	+ 5·62
Jaffna	91·1	+1·7	80·6	+0·5	74	82	3·3	0·00	0	— 2·23
Kandy	89·8	+1·6	70·0	0·0	73	92	5·2	4·60	15	— 1·89
Kurunegala	92·2	+1·2	74·9	+0·2	70	93	5·1	3·71	13	— 6·20
Lunuwila	88·1	—0·5	75·4	—0·2	80	95	5·6	7·16	15	+ 0·32
Mannar	94·2	+0·9	77·8	—0·2	74	84	5·4	1·89	6	— 1·53
Nuwara Eliya	70·8	—0·5	48·7	—1·2	82	93	6·7	11·33	19	+ 6·35
Puttalam	90·6	+1·4	76·4	+0·3	76	88	4·2	4·21	9	— 0·67
Ratnapura	91·0	—0·1	73·6	—0·2	75	95	6·1	11·15	18	— 0·42
Talawakele	78·0	+0·4	56·8	—1·1	78	91	5·6	8·98	17	+ 2·68
Trincomalee	90·3	+1·2	77·7	+0·1	76	86	4·6	1·77	7	— 0·36

For the fourth successive month rain fell in April was below normal over a major portion of the Island. The larger deficits of the order of 5 to 10 inches occurred chiefly in the Province of Sabaragamuwa, Dunedin estate recording 10·43 inches below average. Halwatura estate 9·26 inches and Keragala estate 8·89 inches. Excesses were found among and on the east side of the hills and along the west and the south coasts, the largest being 11·72 inches at Geelong estate, 8·68 inches at Kanankadu, 7·84 inches at West Haputale estate and 7·81 inches at Galle.

The larger monthly totals were of the order of 15 to 20 inches and occurred in places among the hills and in the extreme south. West Haputale estate recording 21·49 inches for the month, Geelong estate 21·39 and Nagrak estate 19·45 inches. Least rain was experianced in the extreme north and along the north-western and the eastern coasts, where the monthly totals were below 2 inches. Some stations in Jaffna Peninsula received no rain at all.

There were four daily falls of five inches or over during the month, the highest being 6·20 inches at Nagrak estate on the 9th.

The weather during April was predominantly of the intermonsoon type, with local scattered afternoon and evening thunderstorms. Under the influence of a low pressure area that formed about the 16th in the East Arabian Sea, weather conditions over the Island became unsettled for a while, and fairly heavy rain was experienced on the 18th. With the approach of the south-west monsoon, conditions became unsettled again towards the end of the month.

Temperatures have on the whole been slightly above average by day and about average by night. The highest recorded shade temperature was 99·2° at Anuradhapura on the 6th, while the lowest air temperature was 35·3° at Nuwara Eliya on the 6th and 7th. Humidities were chiefly above average, while cloud amounts were in deficit. Winds were variable.

D. T. E. DASSANAYAKE,
Superintendent, Observatory.

METEOROLOGICAL REPORT, MAY, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	87·4	+0·6	73·9	—0·6	81	98	8·0	17·97	24	— 8·91
Anuradhapura	92·3	+1·8	77·5	+1·3	70	89	6·0	2·72	5	— 0·82
Badulla	85·4	+0·2	66·5	+0·1	76	95	5·1	7·01	12	+ 2·32
Batticaloa	90.3	+0·1	77·9	+0·1	76	84	7·4	1·79	1	0
Colombo	87·4	+0·4	78·3	+0·8	82	89	7·6	6·60	25	— 8·89
Diyatalawa	78·7	+0·1	63·1	+1·1	74	87	4·5	5·57	15	— 0·49
Galle	85·5	+0·6	78·8	+0·8	84	89	5·8	6·26	23	— 6·41
Hakgala	72·6	—0·6	58·9	+1·0	81	89	4·8	4·25	12	— 4·20
Hambantota	87·0	+0·3	78·4	+1·0	83	89	8·4	4·85	6	+ 0·58
Jaffna	88·7	+0·6	81·8	+0·2	80	83	3·8	0	0	— 2·00
Kandy	88·3	+1·2	72·2	+1·2	74	88	5·9	2·44	12	— 5·13
Kurunegala	89·9	+0·7	77·0	+1·1	74	88	6·3	2·73	12	— 4·82
Lunuwila	87·5	0	78·0	+1·0	82	91	7·5	4·51	21	— 7·42
Mannar	89·8	+0·4	81.0	+0·4	77	82	6·0	0·64	3	— 1·15
Nuwara Eliya	69·6	—0·9	55·0	+1·8	82	91	7·8	3·51	17	— 4·96
Puttalam	88·6	+0·4	79·8	+1·1	78	85	5·8	1·27	9	— 2·50
Ratnapura	88·4	—0·4	75·1	+0·3	83	95	7·2	10·23	27	—10·68
Talawakele	75·8	+0·3	60·6	+0·8	85	94	7·8	9·84	23	+ 0·43
Trincomalee	93·5	+1·6	79·4	+0·7	68	82	5·5	0·44	8	— 2·79

In May too rainfall was below normal almost over the whole Island. Larger deficits occurred in the south-west quarter where the rainfall at several stations was below average by more than ten inches. The largest deficits were 12·58 inches at Sunderland estate, 12·46 inches at Galatura estate and 12·08 inches at Rayigam estate. Small excesses were found in the extreme north and scattered in limited areas elsewhere over the Island, the largest being 5·06 inches at Upper Ohiya estate and 4·95 inches at Dambagalla.

Heaviest rain occurred on the south-western slopes of the hills where several stations recorded monthly totals over 20 inches, the highest being 29·26 inches at Carney estate, 24·49 inches at Arslena estate, 23·90 inches at Padupola and 23·09 inches at Gonapenigala estate. Rainfall gradually decreased outside this area and the monthly totals in the north and the east were generally below 2 inches.

There were six daily falls over 5 inches in May, the highest being 8·46 inches at Moratuwa on the 2nd.

Temperatures were a little above average, particularly night temperatures. The highest recorded shade temperature was 97·7° at Trincomalee on the 22nd, while the lowest air temperature was 46·7° at Nuwara Eliya on the 25th. Humidities were mainly above average. Winds were south-westerly.

Hailstorms were reported from Diyatalawa on the 7th and 8th and from Mandara Nuwara estate Kandapola on the 26th.

D. T. E. DASSANAYAKE,
Superintendent, Observatory.

METEOROLOGICAL REPORT, JUNE, 1948

STATION	TEMPERATURE				HUMIDITY		Amount of Cloud	RAINFALL		
	Mean Maximum	Offset	Mean Minimum	Offset	Day	Night (from Minimum)		Amount	No. of Rainy Days	Offset
	°	°	°	°	%	%		Ins.		Ins.
Agalawatta	86·0	+0·8	72·9	—1·3	84	98	8·4	24·12	30	+ 6·66
Anuradhapura	91·8	+2·1	76·8	+0·4	68	88	7·9	1·27	10	+ 0·54
Badulla	86·3	+1·0	65·9	+0·6	67	92	5·6	0·22	3	— 1·32
Batticaloa	92·7	+0·4	78·6	+1·0	66	76	8·0	0·10	2	— 0·79
Colombo	85·8	+0·4	77·4	+0·1	82	89	8·6	11·55	25	+ 2·89
Diyatalawa	77·4	—0·2	63·7	+0·5	68	79	5·8	1·27	3	— 0·69
Galle	84·5	+0·9	77·4	+0·1	84	86	6·5	12·10	23	+ 3·66
Hakgala	67·9	—0·7	58·7	+0·4	87	89	7·6	7·55	17	+ 0·94
Hambantota	85·4	—1·1	76·7	—0·1	85	91	9·3	0·81	9	— 1·30
Jaffna	86·9	+0·3	81·2	+0·3	80	83	4·8	1·25	1	+ 0·86
Kandy	83·9	+0·5	71·9	+0·7	79	88	7·8	14·56	21	+ 5·73
Kurunegala	87·9	+1·3	75·8	+0·2	78	88	7·0	6·90	22	+ 0·11
Lunuwila	85·6	0	77·3	+0·2	83	91	8·0	8·17	21	+ 0·51
Mannar	88·3	+0.1	81·1	+0·5	78	81	7·0	0	0	— 0·36
Nuwara Eliya	65·6	—0·2	55·0	—0·7	86	94	9·0	14·17	23	+ 3·74
Puttalam	86·8	+0·5	79·6	+0·4	78	85	6·6	1·38	9	— 0·02
Ratnapura	86·8	+0·1	74·6	—0·1	83	95	7·7	20·05	28	+ 1·50
Talawakele	71·5	+0·6	60·6	+0·2	88	94	9·0	17·20	23	+ 3·92
Trincomalee	94·5	+2·4	79·7	+0·7	65	78	7·0	0·05	2	— 0·88

Rainfall in June was, in general, above normal in the south-west quarter and a lettle below normal elsewhere. The larger excesses were found on the south-western slopes of the hills and included 16·32 inches at Kabaragalla estate, 15·83 inches at Oonoogaloya estate and 15·50 inches at Padupola. The largest deficits were 4·18 inches at Carney estate, 3·23 inches at Halwatura estate and 3·10 inches at Kanangama estate.

Heaviest rain also occurred on the south-western slopes of the hills where a number of stations recorded over 25 inches for the month, the highest totals being 51·11 inches at Watawala, 46·78 inches at Padupola and 45·69 inches at Kenilworth estate. There was very little rain outside the south-west quarter,the monthly totals being generally below 2 inches. Many stations in the Northern and Eastern Provinces received no rain at all.

There were 16 daily falls of 5 inches or over, a majority of them occuring on the 15th. The highest was 8·75 inches at Watawala on this day.

South-west monsoonal weather was prevelent throughout the month. Very little rain was experienced up to the 8th. An appreciable steepening of the pressure gradient on the 9th resulted in as spell of strong monsoonal weather ; strong south-westerly winds and increased rainfall in the south-west quarter. Although on the 12th there was a slight improvement, active moonsoonal conditions were in control till the end of the month. Wettest days were the 10th and 11th, and the period 15th to 20th.

Temperatures were a little above average. The highest recorded shade temperature was 98·0° at Trincomalee on the 2nd and 4th, while the lowest air temperature was 47·8° at Nuwara Eliya on the 2nd. Humidities were above average by day, and generally about average by night. Winds were south-westerly, and above average strength.

D. T. E. DASSANAYAKE,
Superintendent, Observatory.

LIST OF ACCESSIONS TO THE LIBRARY, DEPARTMENT OF AGRICULTURE, MARCH 1, 1948, TO MAY 31, 1948.

BOOKS.

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2. An Outline of British Crop Husbandry—by Sanders, H. G.
3. Methods of Plant Breeding—by Hayes and Immer. (Issued to Agricultural Research Office South East Division.)
4. Barlow's Tables of Squares, Cubes, &c.—by Comrie, L. G.
5. A Manual of Tropical Citrus Culture—by Stephenson.
6. Agricultural Machinery—by John Davidson, J. B.
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9. Key to Advanced Accounts (5th Edition)—by Goodman, R. A.
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13. Elements of Tropical Soil Science—by Eden, T.
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17. United States Census of Agriculture, 1945—by Ray Henley.
18. Mechanics in Miniature—by Marshall, P. (Issued to Agricultural Engineer.)
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20. Miniature Buildings Construction by Abern. Issued to Agricultural Engineer.)
21. International Yearbook of Agricultural Statistics, Vol. I., 1941–43 to 1945–46.
22. International Yearbook of Agricultural Statistics, 1941–43 to 1945–46, Vol. II.—by F. A. O.
23. International Yearbook of Agricultural Statistics, 1941–43 to 1945–46, Vol. III.—by F. A. O.
24. International Yearbook of Agricultural statistics, Supplement to Vols. I., II., III.—by F. A. O.
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29. The Science and Practice of Conservation Grass and Forage Crops, Vol. II.—by Watson, S. J. (Issued to Chemist.)
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33. The Newer Knowledge of Nutrition, 5th Edition—by Mccollum, Orent Keilles & Hay. (Issued to the Chemist.)
34. Report on the Progress of Applied. Chemistry Vol. XXXI. 1946.—by Society of Chemical Industry.
35. Workshop Calculations for Machine Tool Operators—by Williams, G. (Issued to the Agricultural Engineer.)
36. An Introduction to Social Biology—by Dale, A. (Issued to Entomologist.)
37. A Treatise on the One-Humped Camel—by Leese, A. S. (Issued to Veterinary Research Officer.)
38. Queen Breeding for Amateurs—by Abbott, C. P. (Issued to Entomologist.)
39. Animal Management, 1933—by Anon. (Issued to Veterinary Research Officer.)
40. Flemings Practical Horseshoing—by Macqueen, J. (Issued to Veterinary Research Officer.)
41. Keeping a Dog—by Wall, R. F. (Issued to Veterinary Research Officer.)
42. Diagram of the Udder of the Cow, of the Ox, and of the Ewe. (Issued to Veterinary Research Officer.)
43. Bailliere's Popular Atlas Model of the Ox—by Anon. (Issued to Veterinary Research Officer.)
44. Anatomical Model of the Mare—by Anon. (Issued to Veterinary Research Officer.)
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2. British Science News.
3. Brittonia.
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5. Canada Department of Agriculture—Current Review.
6. Commonwealth Agriculturist.
7. Corono Club Bulletin.
8. Hongkong Department of Agriculture—Food and Flowers.
9. N. A. P. T. Bulletin.
10. North Carolina State College of Agriculture and Engineering—Annual Report.
11. North Carolina Agricultural Experiment Station Bulletins.
12. Office International des Epizooties Bulletins.
13. Rivista de Agriculture de Puerto Rico.
14. United Planting Association of Malaya Annual Reports.